SASK. LEGISLATIVE LIBRARY
MAY 12 1982
REGINA

ECOLOGICAL INVESTIGATIONS OF THE COALFIELDS COMMUNITY PASTURE

Prepared for
Prairie Farm Rehabilitation Administration
(PFRA)

by
Z. M. Abouguendia
R. C. Godwin
L. A. Baschak

SRC Technical Report No. 124
March, 1982
SRC Publication No. C-805-14-E-82

EXECUTIVE SUMMARY

INTRODUCTION AND OBJECTIVES

The Coalfields Community Pasture is located astride the Souris River approximately 13 miles west of Estevan, Saskatchewan. It consists of 27 fields varying in size from 65 ha to 1304 ha and covers a total area of 13,477 ha. The climate of the pasture area is classified as cold, dry, subhumid with a mean annual precipitation of 410 mm.

The present study of the Coalfields Community Pasture is part of PFRA's ongoing evaluation of management practices and procedures in its Community Pasture Program. Proper management of rangeland aims at obtaining maximum sustained yield of the optimum combination of goods and services, mainly forage production in the case of the Coalfields Community Pasture. The maximum sustained yield is determined by the capability of the range ecosystem. The first prerequisite for planning for range management and improvement is, therefore, the determination of the potential productivity of the rangeland ecosystems involved. This is met by classifying rangeland into range sites, i.e. kinds of rangeland with different capabilities to produce characterstic plant communities. The present status of rangeland vegetation may, however, differ from the potential plant community (climax) as a result of management practices, e.g. grazing intensity. Therefore, it is essential to relate the present vegetation to the potential expected for the range site under consideration, i.e. range condition classification. Consequently, the main objectives of the present study were: (1) to identify,

differentiate and describe the range sites of the study area, and (2) to evaluate range condition in the major fields in the pasture. The study consisted of field investigations conducted in 1981 as well as examination and interpretation of air photos and available information.

MAJOR FINDINGS AND CONCLUSIONS

Soils and Vegetation

The soils of the study area are predominantly Dark Brown Chernozemic largely developed in glacial till. Sandy loam, loam and sandy clay loam are the dominant soil textural classes in the area. Topography generally ranges from moderately undulating to moderately rolling.

Most of the soils of the pasture area have been placed in Classes 5 and 6 according to the soil capability classification for agriculture. Soils in these classes are capable only of producing perennial forage crops. The main limitations include insufficient soil moisture holding capacity, excess stoniness and unfavourable topography.

The organic C and total N in the soils of the area are comparable to or greater than those of similar soils under native mixed grass vegetation. However, available N and P appear to be generally low.

The vegetation of the pasture area is largely a mosaic of grass and shrub types. Predominantly grass types cover 57% of the pasture area, while predominantly shrub types occupy 29% of the area. Other minor types include shrub-grass-aspen and grass-meadow-wetland complexes.

Range Sites

The study area has been classified as a complex of Loamy and Sandy Range Sites. The Loamy Site occurs on nearly level to strongly undulating uplands and moderately to strongly sloping valley and coulee sides. It occupies the largest proportion of the area. The soils are well drained, moderately thick to thin and loamy to sandy clay loam in texture. Soil taxonomic units in this site include Forget loam, Hillsborough loam and Hillwash. Under a climax condition (or excellent range condition) the Loamy Range Site is dominated by western porcupine grass which contributes an average of 40% of the total potential yield. Associated species include wheatgrasses, green needlegrass and upland sedges. Carrying capacity is estimated to be 0.8 ha/AUM (Animal Unit Month).

The Sandy Range Site occurs on nearly level to strongly undulating uplands and to a lesser extent on moderately to strongly sloping valley and coulee sides. The soils are excessively drained, moderately thick to thin with sandy loam texture. Soil taxonomic units in this site include Forget sandy loam, Hillsborough sandy loam, and to a lesser extent Hillwash soils. Under a climax or undisturbed condition the Sandy Range Site is dominated by sand grass which contributes an average of 50% of the total yield. Associated species include western porcupine grass, needle-and-thread and upland sedges. Carrying capacity is estimated to be 1.6 ha/AUM.

Range Condition

Range condition was evaluated according to the climax proportion present as follows:

Class	Climax Percentage Present	Conventional Nomenclature	Explanation
A	76 to 100	Excellent	Satisfactory condition, no significant deterioration.
B	51 to 75	Good	Significant deterioration resulting mainly from continued heavy grazing
C	26 to 50	Fair	Serious deterioration resulting mainly from continued heavy grazing
D	0 to 25	Poor	Extremely severe deterioration resulting mainly from continued heavy grazing

Range condition varied both within and among fields. The overall condition rating for the predominant range site (Loamy) ranged from 51% (Class B, Good) to 77% (Class A, Excellent). However, only two fields were shown to have a satisfactory range condition (Class A). The noted deterioration in range condition in the remaining fields is likely a result of prolonged periods of past overuse (overgrazing).

Range condition ratings as low as 32% (Class C, Fair) were observed in some fields. The wide range of condition ratings noted appears to be a reflection of differences in site characteristics (e.g. topography, distance to water) and plant community characteristics (e.g. species composition, palatability, susceptibility to grazing).

The apparent trend (direction of change) in soil condition is generally upward (improving), possibly due to the generally reduced stocking rates in recent years. The overall vegetation trend analysis showed a very slight downward (deteriorating) trend.

Although the browse condition data collected in the present study is very limited due to the reconnaissance nature of the survey, it can be concluded that the overall browse condition in areas grazed by livestock and wildlife (inside the pasture) appears to be similar to that in areas assumed to be grazed by wildlife only (outside the pasture). Therefore, no negative interaction is suspected.

Grazing Capacity and Stocking Rates

Grazing capacity estimates were derived for each of the major fields after considerations were given to the following:

(1) available literature

(2) actual stocking rates (1959-1981)

(3) range site characteristics

(4) present range condition and trend

(5) utilization patterns observed

(6) plant community characteristics (yield, lifeform and density)

(7) palatability of the dominant species.

The overall grazing capacity estimates varied between fields (0.81 to 3.8 ha/AUM (Animal Unit Month), usable area basis). The overall average for the pasture is 0.98 ha/AUM. This translates into a total of 2,333 AU for a five-month grazing season.

The recommended stocking rates were determined upon adjustment of the carrying capacity estimates obtained on the basis of the present range condition. This affected only those fields with an average range condition class below "Class A". The recommended rates range from 0.85 ha/AUM to 4.74 ha/AUM depending on the field. The overall average for the pasture is 1.23 ha/AUM. The total stocking rate recommended at present is

estimated to be 1863 AU for a five-month grazing season. This represents a reduction of approximately 20% from the estimated grazing capacity, a necessary measure to induce progression or an upward trend to enable the attainment of the potential productivity (Excellent Range Condition). The pasture was stocked in 1981 at a rate near the potential grazing capacity.

RECOMMENDATIONS

Stocking Rates

It is recommended that stocking rates formulated on the basis of this study be followed starting in 1982 in order to provide for maintenance and improvement of range condition in the pasture. It is expected that recovery will take several to many years but can be speeded up considerably by implementation of the appropriate range improvement measures as indicated below.

Range Improvement

(1) It is recommended that large-scale range fertilization trials be conducted in the pasture area to determine the most economical fertilization rate. A substantial increase in yield (up to 200-400%) and quality of forage is expected. Furthermore, fertilization could improve livestock distribution. In addition, the benefits from fertilization are not restricted to the year of application.

(2) It is recommended that shrub (mainly western snowberry) control be considered as a means of range improvement in the pasture area. Predominantly shrub types cover nearly one-third of the area. Negligible grass production is noted in dense snowberry stands. It is expected

that the reduction in snowberry density would result in a substantial increase (up to a 3-fold increase in some areas) in grass production.

(3) It is recommended that appropriate measures be taken to improve grazing distribution. Additional cross-fencing is required in several fields to enable better use of the upland areas. This should be accompanied by appropriate development of watering points. Salt blocks and oilers should not be placed close to watering points. Proper selection of their location is essential to avoid excessive "sacrifice" areas and improve grazing use in areas further away from the water.

Range Evaluation

(1) It is recommended that additional field data be obtained to improve the tentative utilization guide prepared in the present study. The present guide was based on one year's data. Additional data on the weight-height relationship of the key species would improve the accuracy of the guide. The guide should provide a simple, rapid and effective means of evaluating actual use for many pastures in the Weyburn area.

(2) It is recommended that range condition and trend be resurveyed every few years (depending on the type of range improvement procedure adopted) in a selected number of fields in the Coalfields Pasture. While the stocking rates developed in the present study represent the best estimates on the basis of the presently available data, future monitoring of range condition and trend would provide additional data for further refinement of grazing capacity estimates.

General

(1) It is recommended that standardized approaches and methodology for range evaluation and analysis in PFRA pastures be developed. An outline of the recommended procedure has been developed and presented in this report. While it is recommended that this procedure be applied to all PFRA pastures, it is realized that only gradual implementation would be possible in view of the large number of pastures involved, staff limitations and financial constraints. Therefore, it is strongly recommended that the following aspects be given high priority:

(a) A reconnaissance range condition survey of the pastures administered by PFRA. The survey would be limited to a number of "diagnostic" fields to be selected upon examination of air photos and past use records. The main purpose is to identify "problem pastures" where more intensive surveys are urgently needed.

(b) A compilation of relevant available information for each pasture. This should be useful in providing a preliminary assessment and a background for the more comprehensive range analysis to be conducted in the future. This information should include such aspects as soils, vegetation, wildlife, precipitation, actual stocking rates, seeding and spraying for brush control.

(2) It is recommended that a pasture data system be developed and operated. The recommended data system is needed to store, retrieve and analyze the data to be generated by the range evaluation procedure recommended. Such a system is essential due to the large numbers of pastures administered by PFRA and the magnitude and variety of data expected.

ACKNOWLEDGEMENTS

The authors wish to thank G. Luciuk, Soil and Water Conservation Branch (PFRA, Regina) for his efforts and cooperation, particularly during the developmental stages of the study. The assistance and cooperation of G. Chu (PFRA, Regina), K. Thompson and M. McKegney-Clay (PFRA, Weyburn), P. Cozac (PFRA, Coalfields Pasture Headquarters), and W. Fink (PFRA, Regina) are greatly appreciated.

Thanks are also due to W. Sawchyn, Head, Environmental Studies Section (SRC, Saskatoon) for his understanding, cooperation and encouragement throughout the study. Field assistance provided by J. Haraldson of Saskatoon is appreciated.

TABLE OF CONTENTS

		Page
EXECUTIVE SUMMARY		i
ACKNOWLEDGEMENTS		ix
TABLE OF CONTENTS		x
LIST OF FIGURES		xii
LIST OF TABLES		xiii
LIST OF APPENDICES		xv
1	INTRODUCTION	1
2	METHODOLOGY	5
	2.1 Soils	5
	2.2 Flora and Vegetation	5
	2.3 Range Sites	7
	2.4 Range Condition	7
	2.5 Trend in Range Condition	11
	2.6 Browse Condition	11
	2.7 Yield	12
	2.8 Utilization	12
	2.9 Grazing Capacity and Stocking Rates	13
3	RESULTS AND DISCUSSIONS	14
	3.1 Climate	14
	3.2 Soils	14
	3.3 Flora and Vegetation	22
	3.4 Range Sites	27
	3.5 Range Condition	28
	3.6 Trend in Range Condition	35
	3.7 Browse Condition	37
	3.8 Yield	40
	3.9 Utilization	45
	3.10 Grazing Capacity and Stocking Rates	49
4	SUMMARY AND CONCLUSIONS	56
	4.1 Introduction	56
	4.2 Climate	56
	4.3 Soils	56

TABLE OF CONTENTS (Cont'd)

	Page
4.4 Flora and Vegetation	57
4.5 Range Sites	58
4.6 Range Condition and Trend	58
4.7 Yield	59
4.8 Utilization	60
4.9 Grazing Capacity and Stocking Rates	60
5 RECOMMENDATIONS	62
LITERATURE CITED	69
APPENDICES	72

LIST OF FIGURES

Figure		Page
1.1	Location Map of the Coalfields Community Pasture	2
1.2	Range Facilities Map of the Coalfields Community Pasture	3
2.1	Location of Sampling Areas - 1981	6
2.2	One of the Grassland Relic Areas Sampled for Determination of the Potential Natural Vegetation (Climax)	8
3.1	Soil Map of the Study Area	16
3.2	Range Types of the Study Area	24
3.3	The Proportion of the Fine Mineral Material in the Soils under Various Vegetation Types	29
3.4	Range Condition and Trend of the Major Fields in the Study Area	34
3.5	Examples of Areas in Different Range Condition Classes	36
3.6	The Tentative Utilization Guide Constructed and Used in the Present Study	46
3.7	Average Actual Stocking Rates for the Coalfields Community Pasture (1959-1981)	50
5.1	Recommended New Cross Fences and Watering Points for the Coalfields Community Pasture	65
5.2	Recommended Procedure for Range Analysis in P.F.R.A. Community Pastures	67

LIST OF TABLES

Table		Page
2.1	Range Condition Classes and Their Meaning	10
3.1	Average Precipitation (mm) of the Study Area as Approximated from the Estevan Weather Station	15
3.2	Soil Types of the Coalfields Community Pasture Area	17
3.3	Areal Extent (ha) of the Various Soil Types in the Coalfields Community Pasture	18
3.4	Physical and Chemical Analysis of Soils Sampled from the Coalfields Community Pasture (1981)	20
3.5	Area (ha) Occupied by the Various Vegetation Types in the Coalfields Community Pasture	23
3.6	A Comparison of Floristic Composition of the Main Range Types in the Coalfields Community Pasture	26
3.7	Classification of Some Vascular Plant Species Found in the Coalfields Community Pasture According to their Response to Grazing by Cattle . .	30
3.8	Summary of Range Condition Ratings (%)	33
3.9	Trend in Soil Condition in the Coalfields Community Pasture - 1981	38
3.10	Trend in Vegetation Condition in the Coalfields Community Pasture - 1981	39
3.11	Browse Condition in Selected Fields in the Coalfields Community Pasture and in Adjacent Areas Outside the Pasture - Western Snowberry (*Symphoricarpos occidentalis*)	41
3.12	Browse Condition in Selected Fields in the Coalfields Community Pasture and in Adjacent Areas Outside the Pasture - Wolf Willow (*Elaeagnus commutata*)	42

LIST OF TABLES (Cont'd)

Table		Page
3.13	Average Maximum Standing Crop of the Main Range Types	43
3.14	Summary of Key Species (Western Porcupine Grass) Utilization Data - September 2-3, 1981	47
3.15	Areal Extent (ha) of Usable Rangeland in the Coalfields Community Pasture	51
3.16	Estimated Carrying Capacity of the Various Fields in the Coalfields Community Pasture	53
3.17	Recommended Stocking Rates for the Various Fields in the Coalfields Community Pasture	55

LIST OF APPENDICES

APPENDIX		Page
A	Terms of Reference of the Present Study	73
B-1	Location and Description of Areas Where Soil Samples were Collected	75
B-2	Number of Sampling Areas Examined in the Range Condition Survey	78
B-3	An Example of Range Condition Calculations (Field B2c - Loamy Site)	79
B-4	Parameters Used in Evaluating Trend in Range Condition	82
B-5	Number of Locations Surveyed for Trend	83
B-6	Number of Locations Where Browse Condition was Examined	84
B-7	Form Used in the Browse Condition Survey	85
B-8	Number of Quadrats Clipped for Determination of Maximum Standing Crop (Yield)	86
B-9	Location and Number of Samples Used in the Utilization Survey	87
C-1	Complete Analysis of the Soil Samples Collected from the Coalfields Community Pasture in 1981	88
C-2	Textural Analysis of the Soil Samples Collected from the Coalfields Community Pasture in 1981	89
C-3	Percentage Organic Carbon in the Coalfields Soil Samples	90
C-4	Percentage Total Nitrogen in the Coalfields Soil Samples	91
C-5	A List of Vascular Plant Species Found in the Study Area	92

LIST OF APPENDICES (Cont'd)

APPENDIX		Page
C-6	Average Species Composition as Estimated in the 1981 Field Survey - Loamy Site (*Stipa - Agropyron*)	94
C-7	Average Species Composition in the 1981 Survey - Sandy Site (*Calamovilfa - Stipa*)	95
C-8	Description of Main Range Sites Identified in the Coalfields Community Pasture	96
C-9	Physical and Chemical Analysis of Soil Samples Collected from the Coalfields Community Pasture (1981)	98
C-10	Proportion of the Climax Species Composition Present - Loamy Site	99
C-11	Proportion of the Climax Species Composition Present - Sandy Site	100
C-12	Maximum Standing Crop Data - Coalfields Community Pasture - 1981	101
C-13	Analysis of Variance of the Maximum Standing Crop Data	105
C-14	Summary of Data Used in Construction and Verification of the Western Porcupine Grass Utilization Guide	106
C-15	Summary of the Actual Stocking Rates (ha/AUM) of the Coalfields Community Pasture (1959-1981)	107

1. INTRODUCTION

The present ecological rangeland study of the Coalfields Community Pasture (Figure 1.1) is part of PFRA's ongoing evaluation of management practices and procedures in its Community Pasture Program. The main objective of the study is to provide a biophysical inventory and a range condition assessment of the pasture. The study is intended as an intensive pilot project to demonstrate the survey approaches and procedures for possible application in other pastures administered by PFRA.

The Coalfields Pasture is located in the Mixed Prairie Grassland Zone. It covers an area of approximately 13,477 ha (33,288 acres) and is divided into a total of 27 fields ranging in size from 65 ha (160 acres) to 1,304 ha (3,220 acres) (Figure 1.2).

The study consisted of field investigations as well as examination and interpretation of recent air photos and available published and unpublished information. Field work was conducted between July 29 and September 28, 1981.

The main steps in the development of the present study are:

(1) Identification and characterization of the main range sites in the pasture area. This was based on interpretation of data on the climax or potential natural vegetation and soils of the area.

(2) Estimation of the carrying capacity of the main fields. This was accomplished after consideration of range site characteristics, vegetation type and productivity, past use history and other available data.

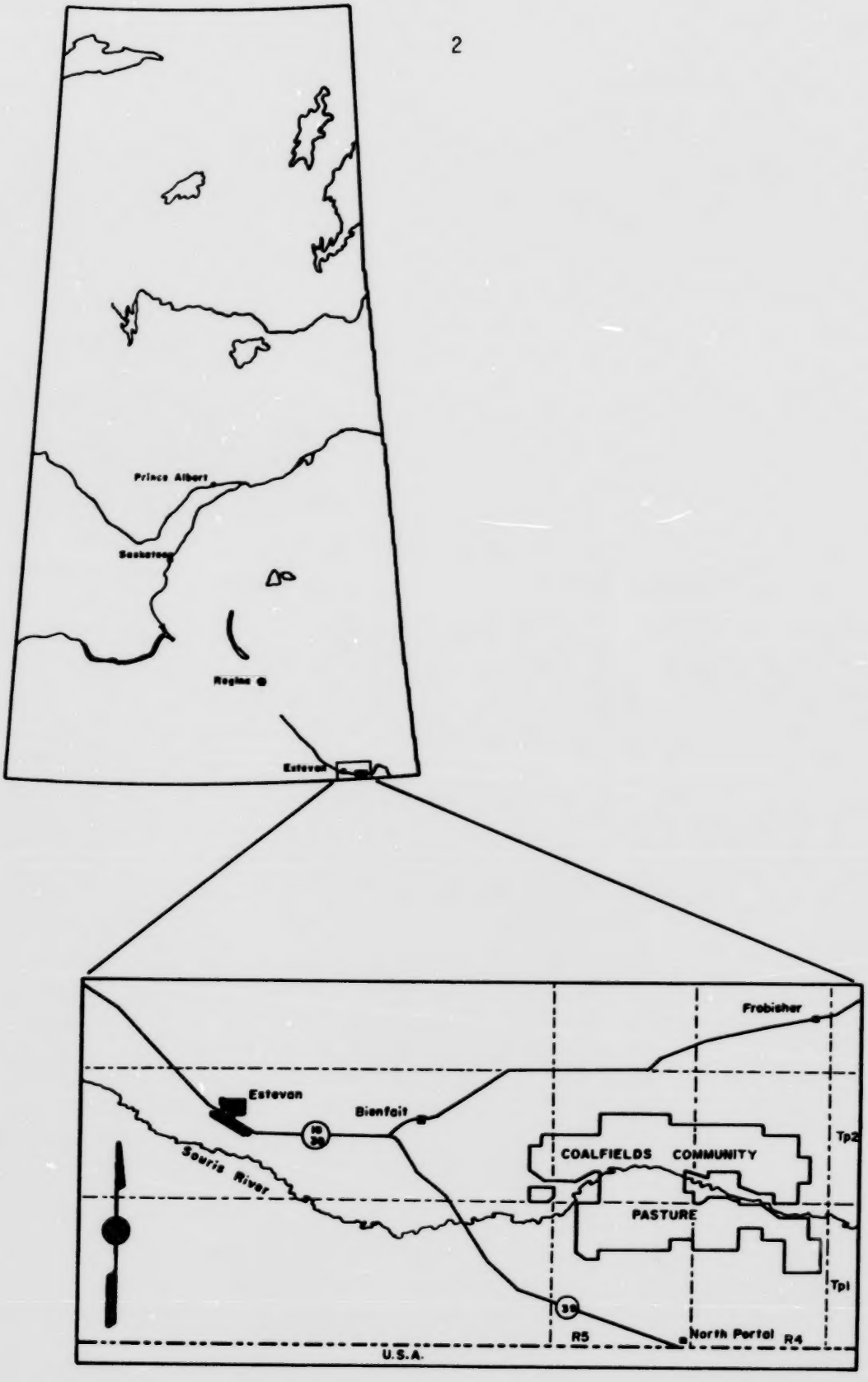


Figure 1.1 Location Map of the Coalfields Community Pasture.

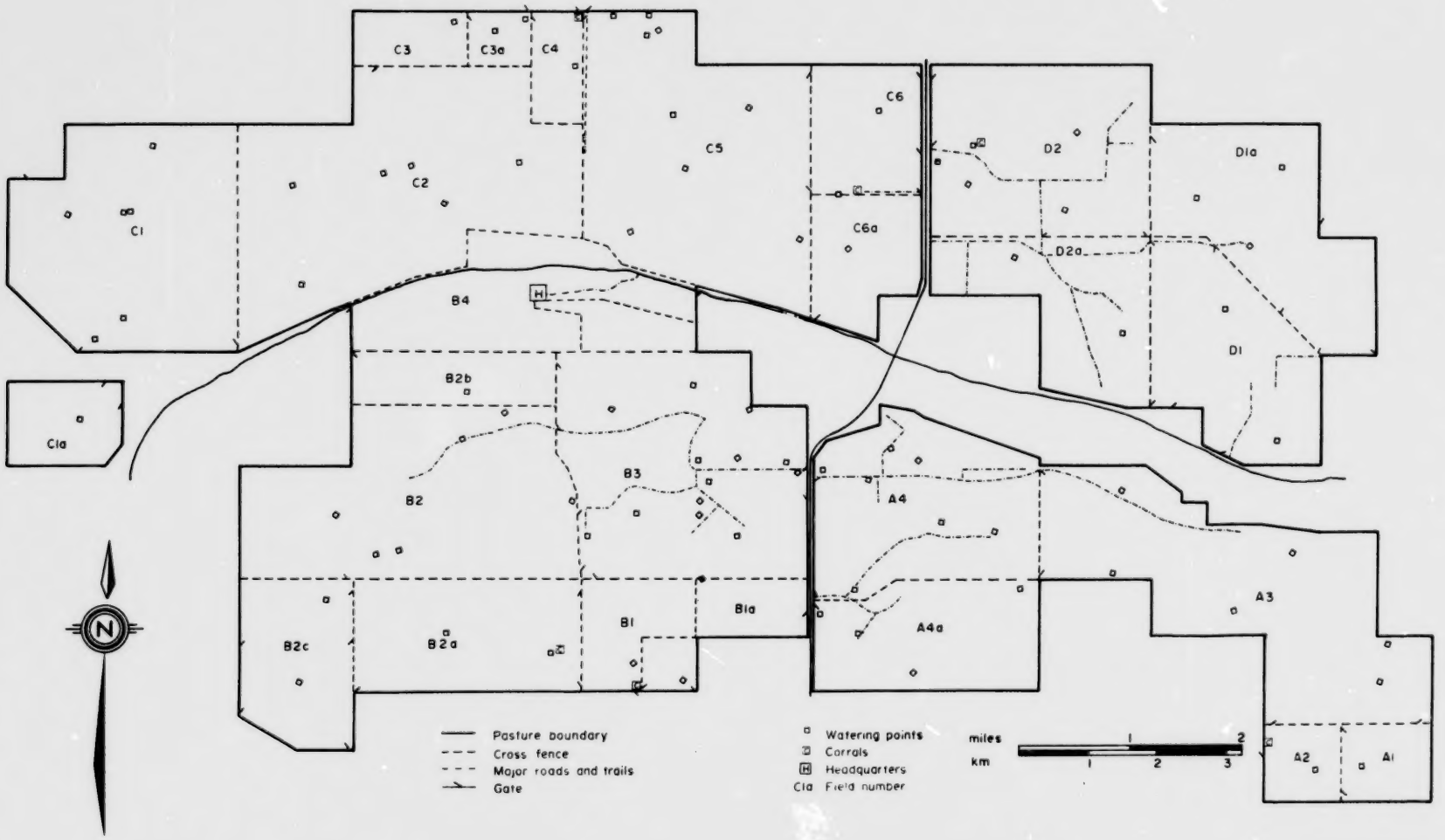


Figure 1.2 Range Facilities Map of the Coalfields Community Pasture.

(3) Estimation of stocking rates to be recommended at present to ensure future maintenance or improvement of the range resources. This required consideration of range site characteristics, range type characteristics, present range condition and trend, utilization patterns and past use.

(4) Identification of options for improving the productivity and management of the pasture.

(5) Formulation of an outline of a follow-up plan required to ensure maintenance and/or improvement of range condition in the pasture area.

The terms of reference of the present study are given in Appendix A.

2. METHODOLOGY

2.1 Soils

Soil samples were collected from areas of various vegetational and physiographic characteristics (Appendix B-1, Figure 2.1) to supplement available soils data and to enable more objective determination of range sites. Both A (0-12 cm) and B (5-35 cm) horizons were sampled.

The samples collected were analyzed by the Saskatchewan Soil Testing Laboratory for the following parameters: (1) texture, (2) pH, (3) electrical conductivity, (4) organic carbon, (5) total nitrogen, and (6) available nitrogen, phosphorous and potassium.

A soils map was prepared for the study area mainly on the basis of available information (Anderson, 1981). The original working scale was 1:50,000. A Tektronix digitizer with a resolution of 0.1 mm and accuracy of 0.08 mm was employed in the measurement of the areas of various soil types.

2.2 Flora and Vegetation

Vegetation types were mapped upon interpretation of recent (1979) 1:50,000 black and white panchromatic air photos. The areal extent of each type was determined in a manner similar to that of soil types.

A description of natural vegetation was made in stands representing the various vegetation types and range sites. A floristic list was prepared. The list includes the scientific name, common name, growth form (grass, sedge, perennial forb, shrub, tree, etc.) and habitat distribution for each species.

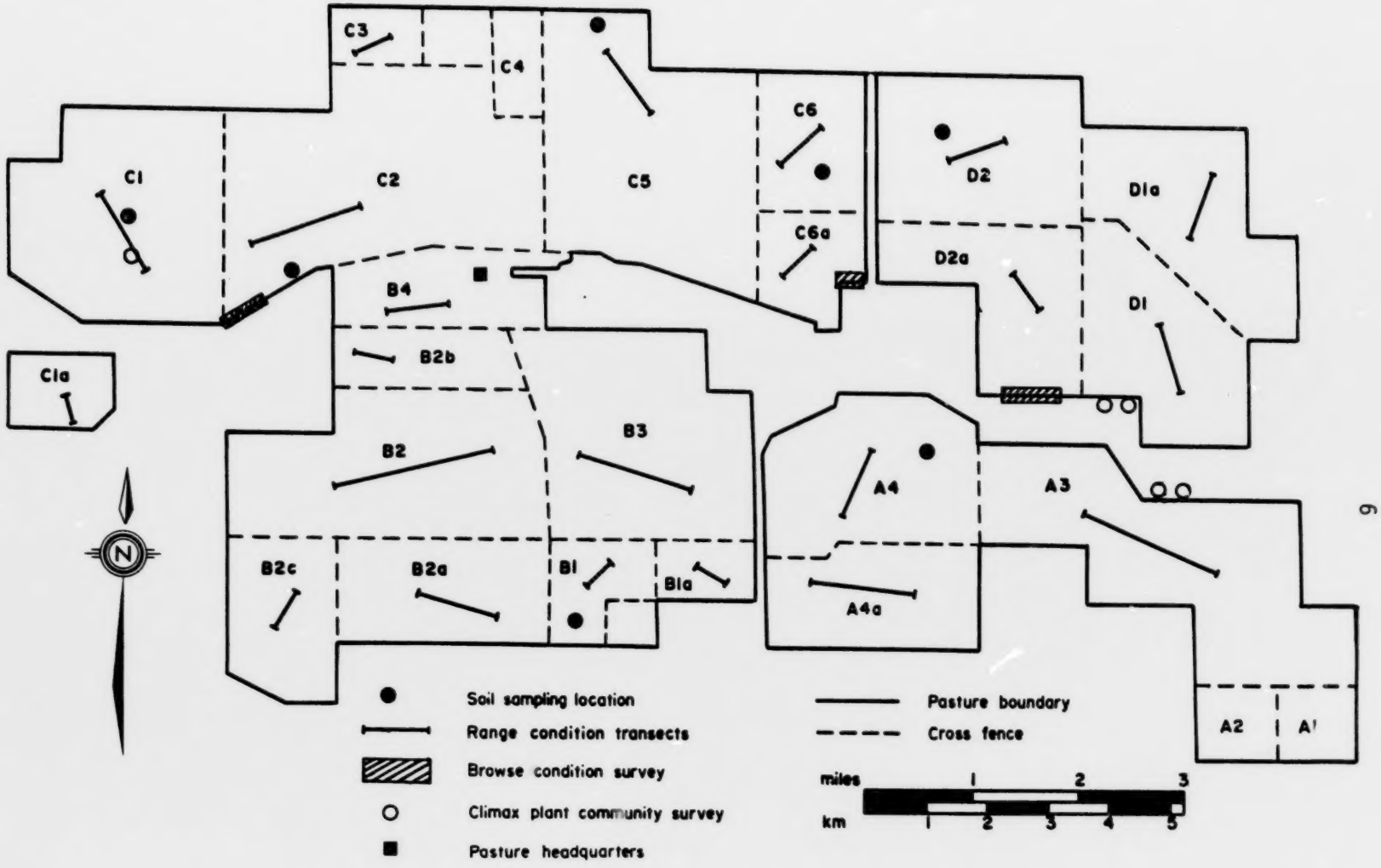


Figure 2.1 Location of Sampling Areas - 1981.

2.3 Range Sites

A range site is a distinctive kind of rangeland that differs from other kinds of rangeland in its ability to produce a characteristic natural plant community. The determination of range sites, therefore, is an essential prerequisite for range condition analysis.

Several grassland relict areas were examined (Figures 2.1 and 2.2) and range sites were determined on the basis of the following criteria:

(1) differences in the ecological dominants in the "climax" plant community

(2) differences in the proportion of the most important species in the "climax" plant community

(3) differences in the total annual production of the "climax" plant community

In addition, differences in soil and topography were used to aid in the differentiation between range sites in grazed areas within the pasture. Relevant literature also was consulted to aid in the description of range sites.

2.4 Range Condition

Range condition is the present state of vegetation of a range site in relation to the climax (natural potential) plant community for that site. It is an ecological rating expressing the relative degree to which the kinds, proportions, and the amounts of plants in a plant community resembles that of the climax plant community for the site.

The method employed in surveying range condition in this study is based on species composition by weight. The survey was conducted along transects located in key areas in each field (Figure 2.1).

Figure 2.2 One of the Grassland Relic Areas Sampled for Determination of the Potential Natural Vegetation (Climax) (left). The Area Across the Fence (Field No. A3) has been Placed in the Low Fair Range Condition Class (see Sections 2.4, 3.5).

Figure 2.2 One of the Grassland Relic Areas Sampled for Determination of the Potential Natural Vegetation (Climax) (left). The Area Across the Fence (Field No. A3) has been Placed in the Low Fair Range Condition Class (see Sections 2.4, 3.5).

A key area meets the following criteria: (1) accessible for livestock grazing, (2) provides a significant amount of forage, and (3) at least 100 m* away from salting and oiling grounds, watering places, and fences. Each transect consisted of a number of sampling areas depending on the size of the field and the homogeneity of vegetation (Appendix B-2). In each sampling area, species composition by weight was visually estimated to the nearest 5% in each of 10 quadrats (0.5 m x 0.5 m) The quadrats were located (about 5 m apart) along a line perpendicular to the main transect. Although the general sampling areas were occasionally subjectively selected to ensure proper representation of the major vegetation types, the exact location of each quadrat was always randomly determined.

Range condition rating was calculated for each range site in each sampling area and then a weighted (on the basis of the number of quadrats per range site) average was obtained for each field sampled. The procedure employed can be summarized as follows:

(1) calculation of the mean species composition for each range site

(2) determination of the proportion of the original or climax species by comparing the mean species composition (Step 1) with the constructed climax composition for the site (Section 2.3) and noting the classification of the main plant species according to their response to continued heavy grazing (See discussions on range condition guides in Section 3.5).

(3) determination of the range condition class by summing up the climax proportions for all species present and then referring to Table 2.1 for range condition classes.

---

*Based on information obtained from a reconnaissance survey involving a selected number of fields.

Table 2.1 . Range Condition Classes and their Meaning.

Class	Climax Percentage Present	Conventional Nomenclature	Explanation
A	76 to 100	Excellent	Satisfactory condition, no significant deterioration.
B	51 to 75	Good	Significant deterioration resulting mainly from continued heavy grazing.
C	26 to 50	Fair	Serious deterioration resulting mainly from continued heavy grazing.
D	0 to 25	Poor	Extremely severe deterioration resulting mainly from continued heavy grazing.

The above procedure is discussed further in Section 3.5 and an example is given in Appendix B-3.

2.5 Trend in Range Condition

The purpose of the range trend survey is to detect the direction of change in the conditions of vegetation and soil thus reflecting current management practices. Two main approaches are used in trend analysis: (1) the measured trend, requiring resurveying of a defined location over a number of years; and (2) apparent trend, based on assessment of a number of parameters reflecting apparent changes in range condition. The latter approach was used in the present study.

Several vegetation and soil parameters (Appendix B-4) such as reproduction, vigor, and litter accumulation were assessed at 42 locations (Appendix B-5) in the main fields. The locations have generally followed those of the range condition survey.

2.6 Browse Condition

A reconnaissance browse condition survey was conducted in three areas (Figure 2.1) along the Souris River Valley to detect possible wildlife (ungulate)-livestock utilization interactions.

In each area, eight or nine sampling stations were examined along two paired transects representing conditions inside and outside the pasture (Appendix B-6). The parameters used included relative degree of hedging, age classes, and presence of dead twigs (Appendix B-7). Two browse species were studied: western snowberry (*Symphoricarpos occidentalis*) and wolf willow or silverberry (*Elaeagnus commutata*).

2.7 Yield (Maximum Standing Crop)

An indication of range productivity can be obtained by clipping vegetation at the time of maximum standing crop* A number of quadrats (0.5 m x 0.5 m) were clipped in each of the major vegetation types (Appendix B-8). Herbaceous vegetation (grasses, grass-like plants, forbs) was clipped at ground level while only current year's growth of shrubs was included. The material obtained was sorted in the field into three categories: graminoids (grasses and grass-like plants), forbs (broad-leaved herbs), and shrubs. The air-dried material was weighed to the nearest 0.01 g.

Areas selected for maximum standing crop determination received slight grazing or no grazing at all during the current growing season.

2.8 Utilization

Current year's utilization was measured using a weight/height approach. Height of the key species (western porcupine grass, *stipa spartea* var. *curtiseta*) was measured in the major fields (Appendix B-9). Data required for determining height-weight relationship for this key species were collected (Appendix B-10). For each sample the weight was obtained for each of the following height increments: 0-2.5 cm, 2.5-5 cm, 5-7.5 cm and > 7.5 cm. In addition, twenty percent of the height survey samples (Appendix B-9) were clipped to provide further verification for the height-weight relationship.

The utilization survey was conducted at the reconnaissance level and is intended mainly to give insight into the utilization patterns in relation to site physical and biological characteristics. Also, a tentative utilization guide was constructed and could be used in

---

*See Appendix B-8 for further comments on the technique used.

future surveys in the Coalfields Community pasture and similar areas with little modification.

2.9 Grazing Capacity and Stocking Rates

Range grazing capacity is defined as the maximum animal numbers which can graze each year on a given area of range, for a specific number of days, without inducing a downward trend in forage production, forage quality or soil. Grazing capacity is difficult to determine because it depends on many factors, including climatic conditions, site characteristics, type and productivity of the main plant communities and the type(s) of grazing animals.

In the present study, grazing capacity was determined on the basis of available literature, past-use history, range site characteristics and plant community characteristics. This is discussed in more detail in Section 3.10.

Recommended stocking rate depends on the grazing capacity of the range and its present condition and trend. Recommended stocking rate equals grazing capacity for ranges in satisfactory range condition (Excellent, Class A). Lower stocking rates are recommended for the other condition classes to provide for range improvement. Stocking could be adjusted upward after a satisfactory range condition class is attained.

3. RESULTS AND DISCUSSIONS

3.1 Climate

The climate of study area is classified as cold, dry subhumid (Chakravarti, 1969). The summers are cool with mean daily July temperature between 15.7 and 19.0^0 C and winters are cold with mean daily January temperature between -15.7 and -20.7^0 C. The mean annual number of growing degree days (>5.6^0 C) is 143.8 and the mean annual number of frost-free days is estimated to be 100 days (McKay *et al*, 1967).

The mean annual amount of precipitation is estimated to be 410 mm on the basis of data from the Estevan weather station (Table 3.1). The May to September precipitation amounts to approximately two-thirds of the total annual precipitation.

3.2 Soils

The soils of the study area are predominantly Dark Brown Chernozemic largely developed in glacial till under heavy grass cover. The soils map of the study area is shown in Figure 3.1 while a description of the soil types appears in Table 3.2. In addition, the area occupied by the different soil types is given for each field in Table 3.3.

Four soil complexes have been identified in the area (Anderson, 1981): Hillsborough, Hillwash, Forget and Alluvium. Within the Coalfields Community Pasture, more than two-thirds of the area has been mapped as Hillsborough Complex. Hillsborough soils developed in loam to sandy loam, very stony glacial till. They are generally excessively to well drained with small areas of wetland in imper-

Table 3.1 Average Precipitation (mm) of the Study Area as Approximated from the Estevan Weather Station (McKay *et al* 1967). *

Month	Precipitation
January	17.5
February	15.0
March	20.0
April	22.5
May	40.0
June	87.5
July	57.5
August	47.5
September	37.5
October	25.0
November	22.5
December	17.5

* 30 year average

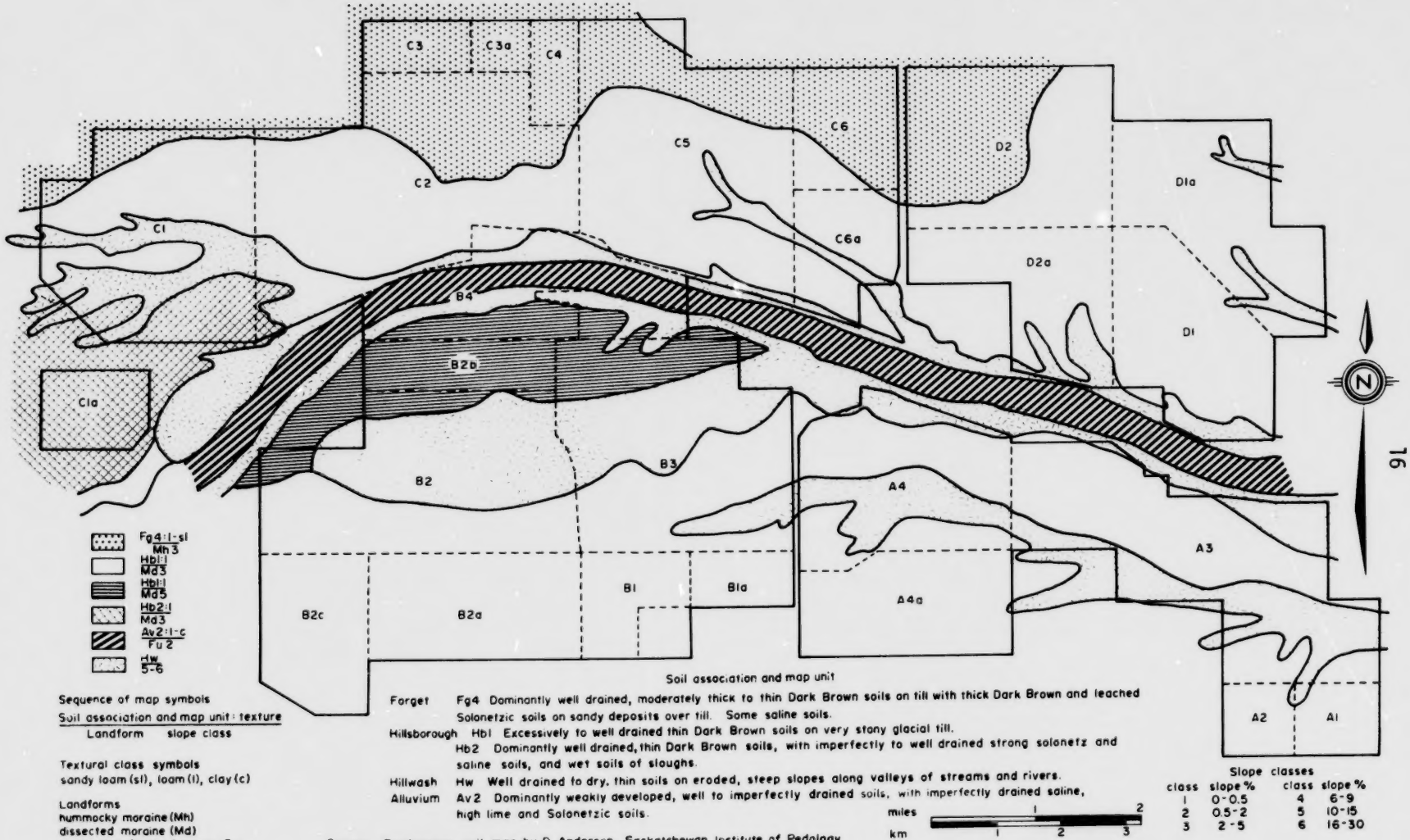

C3
C3a
C4
C5
C6
D2
D1a
C2
C1
C6a
D2a
B4
D1
B2b
C1a
B3
B2
A4
A3
B1
B1a
A4a
B2c
B2a
A2
A1
N
Fg4:l-sl / Mh3
Hb1:l / Md3
Hb1:l / Md5
Hb2:l / Md3
Av2:l-c / Fu2
rw / 5-6
Sequence of map symbols
Soil association and map unit : texture
Landform slope class
Textural class symbols
sandy loam (sl), loam (l), clay (c)
Landforms
hummocky moraine (Mh)
dissected moraine (Md)
Undulating fluvial deposits (Fu)
Soil association and map unit
Forget Fg4 Dominantly well drained, moderately thick to thin Dark Brown soils on till with thick Dark Brown and leached Solonetzic soils on sandy deposits over till. Some saline soils.
Hillsborough Hb1 Excessively to well drained thin Dark Brown soils on very stony glacial till.
Hb2 Dominantly well drained, thin Dark Brown soils, with imperfectly to well drained strong solonetz and saline soils, and wet soils of sloughs.
Hillwash Hw Well drained to dry, thin soils on eroded, steep slopes along valleys of streams and rivers.
Alluvium Av2 Dominantly weakly developed, well to imperfectly drained soils, with imperfectly drained saline, high lime and Solonetzic soils.
Source Preliminary soil map by D. Anderson, Saskatchewan Institute of Pedology
miles 1 2
km 1 2 3
Slope classes
class slope % class slope %
1 0-0.5 4 6-9
2 0.5-2 5 10-15
3 2-5 6 16-30

Figure 3.1 Soils Map of the Study Area.

Table 3.2 Soil Types* of the Coalfields Community Pasture Area.

Soil Type (Complex)	Map Unit**	General Description	Description of Parent Material	Soil Classification	
				Dominant	Significant
Forget Complex	Fg 4	Dominantly well drained, moderately thick to thin Dark Brown soils on sandy loam to loam till; with thick Dark Brown and leached Solonetzic soils on sandy deposits over till. Some saline soils.	Combinations of sandy water-laid deposits over glacial till and sandy loam to loam textured glacial till.	Orthic Dark Brown	(Rego Dark Brown Calcareous Dark Brown) (Saline soils and Gleysolic soils)
Hillsborough Complex	Hb1	Excessively to well drained, thin Dark Brown soils on very stony glacial till.	Loam to sandy loam textured, very stony glacial till. Some sandy to gravelly deposits included.	Orthic Dark Brown	
	Hb2	Dominantly well drained, thin Dark Brown soils; with imperfectly to well drained strong Solonetz and saline soils and wet soils of sloughs.		Orthic Dark Brown	Dark Brown Solonetzic soils (Saline soils and Gleysolic soils)
Hillwash Complex	Hw	Well drained to dry, thin soils on eroded, steep slopes along valleys (Souris River and larger coulees).	Stony, eroded glacial till with gravelly and sandy deposits.	Regosolic, Chernozemic and Luvisolic soils.	
Alluvium Complex	Av2	Dominantly weakly developed, well to imperfectly drained soils, with imperfectly drained saline, high lime or Solonetzic soils.	Sandy loam, silty and silty clay flood plains deposits along streams.	Rego Chernozemic	Saline and/or carbonated Chernozemic, Solonetzic soils

*Source: Unpublished data by D. Anderson, Saskatchewan Institute of Pedology.

**Refers to symbols used in Figure 3.1.

Table 3.3 Areal Extent (ha) of the Various Soil Types in the Coalfields Community Pasture.

Field Number	Hillsborough 1 (5)*	Hillsborough 1 (3)	Hillsborough 2 (3)	Forget 4 (3)	Hillwash (5-6)	Total
A1, A2		279			12	291
A3		710			399	1,109
A4		235			547	782
A4a		502				502
B1		194				194
B1a		130				130
B2	105	392			459	956
B2a		518				518
B2b	219					219
B2c		380				380
B3	189	442			421	1,052
C1		423	178	85	253	939
C1a			194			194
C2		743	26	391	143	1,303
C3				130		130
C3a				72		72
C4				119		119
C5		748		306	79	1,133
C6		63		236		299
C6a		241		3	40	284
D1		547			54	601
D1a		609			60	669
D2		389		389		778
D2a		421			80	501
Total	513	7,966	398	1,731	2,547	13,155

*Topographic classes as shown in Figure 3.1.

fectly drained depressions. Topography ranges from moderately undulating to moderately rolling.

Approximately 19% of the pasture area has been mapped as Hillwash Complex. The Hillwash soils are associated with moderately to steeply sloping valley walls (such as that of the Souris River) and developed in eroded glacial till with variable texture. They are well drained to dry.

The Forget Complex is represented in approximately 13% of the pasture area. It occupies a narrow strip in the northern part of the pasture. The Forget soils developed in moderate to coarse, water-deposited material and glacial till. They are dominantly well drained. The topography is mostly moderately undulating.

The results of the physical and chemical analysis of the soil samples collected during the present study are given in Appendices C-1 to C-4 and are summarized in Table 3.4.

The three main soil types (complexes) do not appear to vary greatly in their texture (Table 3.4). However, greater variations are apparent within each of these types (Appendix C-2). Sandy loam and sandy clay loam appear to be the dominant soil textural classes in the area.

The samples from the Hillsborough soils are lower in organic matter, total nitrogen content, pH and available N than the other two types. The three soils have similar available P and K. The samples from the Forget soils appear to be more saline than those for the Hillsborough and Hillwash complexes.

Table 3.4 Physical and Chemical Analysis of Soils Sampled from the Coalfields Community Pasture (1981). (Values are means ± standard deviation).*

Soil Type (complex)	Horizon	Number of Samples	Mineral Content			% Organic Carbon	% N	Lime	pH	Conductivity (mmhos/cm)	Available Nutrients (ppm)		
			% Sand	% Silt	%Clay						N	P	K
Hillsborough	A	8	50.24± 4.74	30.15± 2.67	19.62±2.73	4.66±1.11	0.3760±0.0510	Absent	6.6±0.6	0.2±0.06	3±1.7	4±1.2	413±142
	B	8	57.49± 6.06	24.80± 3.18	17.72±3.28	1.72±0.32	0.1568±0.0188	Absent to Trace	6.8±0.6	0.1±0.08	2±1.1	2±1.1	273± 86
Forget	A	5	51.12±19.81	29.68±12.92	19.21±7.18	4.82±1.55	0.4338±0.1602	Absent to Low	7.0±0.8	1.4±1.34	15±12	6±1.3	454±100
	B	5	57.29±17.63	24.02± 9.06	18.69±9.41	1.17±0.30	0.1193±0.0304	Absent to High	7.2±0.9	0.9±0.89	6±5	2±1.1	281±112
Hillwash	A	4	50.45± 3.77	26.09± 2.41	23.46±3.74	5.08±0.66	0.4132±0.0723	Absent	7.3±0.3	0.3±0.10	4±2**	6±2**	451± 91
	B	4	50.15± 9.29	23.54± 7.22	26.31±5.39	2.00±0.40	0.1765±0.0613	Absent to High	7.7±0.3	0.2±0.10	2±1**	3±1**	234± 95

*Detailed data are given in Appendices C-1 to C-4.

**One anomalous value (Samples 17, 18) was omitted from the calculations.

The organic carbon content of the soils sampled in the present study is comparable to that of Dark Brown soils under grazed native grassland cover elsewhere in southern Saskatchewan (Lodge, 1954). However, it is more than three times the organic carbon content of similar soils (Weyburn) under cultivation (Acton and Ellis, 1978). This is not unexpected. Substantially greater losses of organic matter have taken place under cultivation than under grazing in the Northern Great Plains (Black and Bauer, 1981 and Marten, 1979). Total nitrogen content is within the ranges reported for grazed mixed prairie grasslands (Kilcher et al., 1965). The C/N ratio is remarkably similar for the different soil types found in the study area and is comparable to that of native mixed prairie in North Dakota (Black and Bauer, 1981).

Available N and P are generally low in the soils of the study area. For example, Lodge (1954) reported available P levels between 10 and 24 ppm for grazed mixed prairie compared to a range of 4 to 6 ppm in the present study.

Most of the soils of the pasture area have been placed in classes 5 and 6 according to the soil capability classification for agriculture (Acton and Clayton, 1967). Soils in these classes are capable only of producing perennial forage crops. The main limiting factors are: insufficient soil moisture holding capacity, excess stoniness and unfavourable topography.

Soil characteristics are discussed further in conjunction with range site determination in Section 3.4.

3.3 Flora and Vegetation

The flora of the study area is highly diverse (Appendix C-5). This is probably due to its location in the transition zone between the Mixed Prairie Grassland Region and the Aspen Parkland Region of the province and the physiographic diversity associated with the Souris River Valley and the major coulees. A total of 108 species of vascular plants were found including 31 grasses, 4 sedges, 58 forbs, 10 shrubs and 4 trees. This number should be considered minimal since no special effort was made to conduct a complete floristic inventory for the area.

It is interesting to note that three grass species designated as rare in Saskatchewan according to Maher *et al* (1979) are present in small amounts in the study area. These are big bluestem (*Andropogon gerardi*), side-oat grama (*Bouteloua curtipendula*) and switchgrass (*Panicum virgatum*).

The vegetation of the study area is largely a mosaic of grass and shrub types. Predominantly grass types cover 57% of the pasture area (Table 3.5, Figure 3.2), while predominantly shrub types occupy 29% of the area. Other minor types include shrub/grass/aspen complex found mainly in the northeastern corner of the pasture and grass-meadow-wetland (or slough) complex associated with the imperfectly drained depressions.

The alluvial flats of the Souris River flood plains are not part of the grazed area of the pasture. Where the natural cover in these areas has not been removed for cultivation a forest vegetation is present.

Table 3.5 Area (ha) Occupied by the Various Vegetation Types* in the Coalfields Community Pasture.

Field Number	Gr/Sh	Gr-Sh	Sh-Gr	Sh/Gr	Gr-Sh/ W-M	Sh-Gr/ Aspen	Broken	Total
A1, A2	90			79	122			291
A3	499	299	300	11				1,109
A4	633		141		8			782
A4a	110			382	10			502
B1				25	169			194
B1a	4		3	3	120			130
B2	669	153	134					956
B2a	285		62	161	10			518
B2b	206			13				219
B2c	68	312						380
B3	463		442	105	42			1,052
C1	216	66	657					939
C1a	194							194
C2		78	535	469	182		39	1,303
C3					130			130
C3a					72			72
C4		37			82			119
C5		1,076			57			1,133
C6	197	18			84			299
C6a	34	250						284
D1		349	252					601
D1a		227	7			435		669
D2		559			86	86	47	778
D2a		451			50			501
Total	3,668	3,875	2,533	1,248	1,224	521	86	13,155

*Gr Grass
W Wetland Vegetation
Sh Shrub
M Meadow Vegetation

(1) Gr/Sh : >75% grass
(2) Gr-Sh : 50-75% grass
(3) Sh-Gr : 50-75% shrub
(4) Sh/Gr : >75% shrub
(5) Gr-Sh/W-M : as in No. 2 but in complex with meadows and wetland
(6) Sh-Gr/Aspen: as in No. 3 but in complex with aspen
(7) Broken : old seeded or broken areas in various successional stages

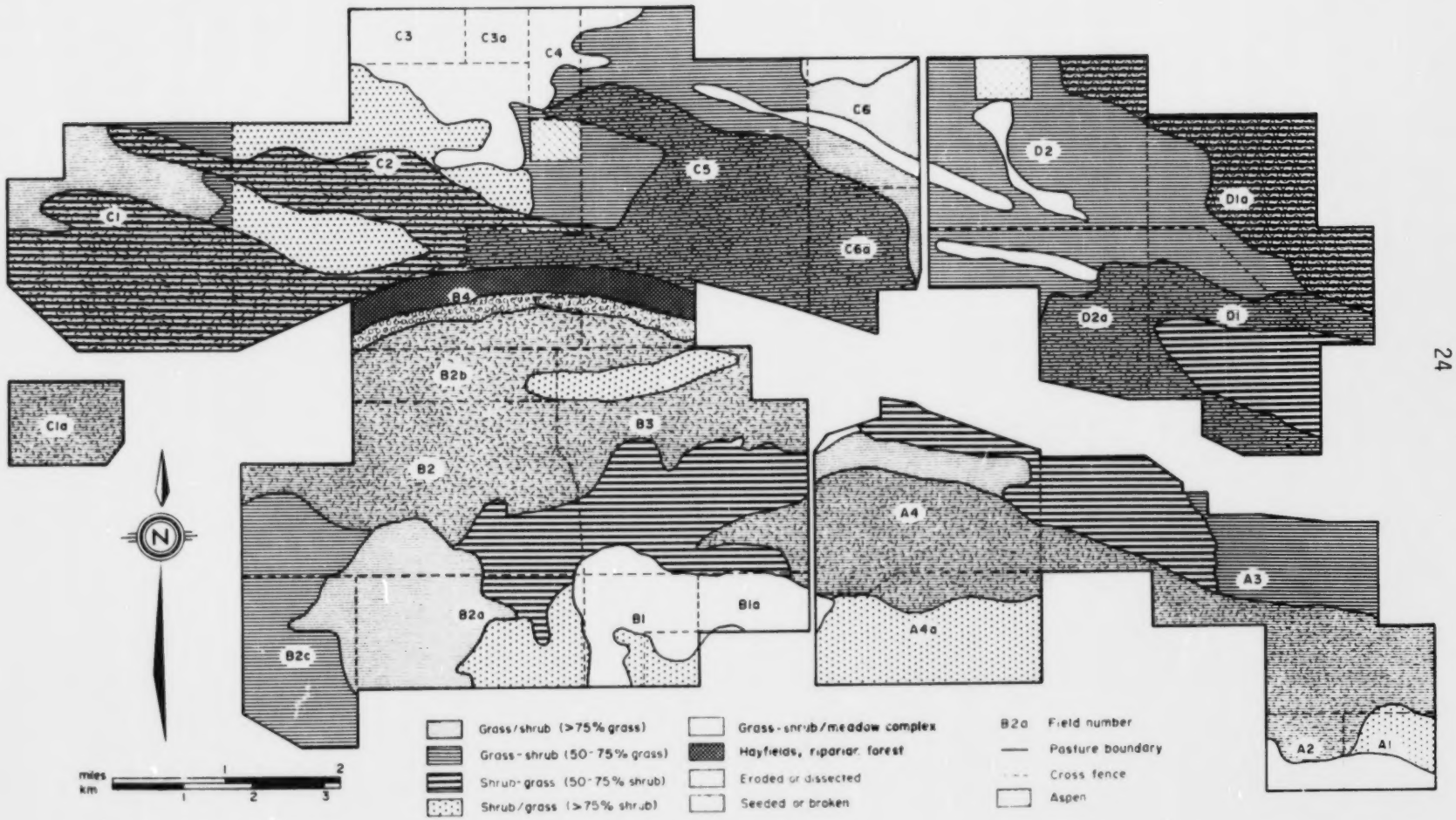


Figure 3.2 Range Types of the Study Area.

A floristic composition of the identified vegetation types is given in Table 3.6, while more detailed information can be found in Appendix C-5. Two grass types or "associations" are found in the area: (1) *Stipa-Agropyron* and (2) *Calamovilfa-Stipa*. Both associations occur as an intricate pattern on the upland classified as Hillsborough and Forget Complexes and on slopes associated with the Hillwash Complex (Section 3.2). The first association is the most important in terms of areal extent as judged from the proportion of total quadrats in which it is present (Appendix C-6). In this association western porcupine grass (*Stipa spartea* var. *curtiseta*) is the dominant species and makes up 7 to 37% of the total yield (Appendix C-6). Important associated species include western wheatgrass (*Agropyron smithii*), sand grass (*Calamovilfa longifolia*), blue grama (*Bouteloua gracilis*) and upland sedges (mainly *Carex filifolia, C. pensylvanica*). The main shrub found in this association is western snowberry (*Symphoricarpos occidentalis*). The main forb species is pasture sage (*Artemisia frigida*). The *Calamovilfa-Stipa* "association" is characterized by nearly the same species compliment. However, sand grass is the dominant species and contributes 40 to 63% of the total yield (Appendix C-7).

The main shrub type in the area is dominated by western snowberry while the main associated species are western porcupine grass and bearded wheatgrass (*Agropyron subsecundum*). In this type, shrub height and density is much greater than in the grass types. Grasses make up a minor proportion of the yield in the shrub type.

Table 3.6 A Comparison of Floristic Composition of the Main Range Types in the Coalfields Community Pasture. Only Major Species are Indicated.* More details are given in Appendix C-5.

Species	Range Types				
	Grass	Shrub	Aspen	Riparian Forest	Slough-Meadow Complex
Graminoids					
Western porcupine grass	D	A			
Sand grass	D				
Western wheatgrass	A	A			C
Bearded wheatgrass	A	A			
June grass	A				
Blue grama	A	A	D		C
Upland sedges	A	A			
Native slender wheatgrass			A		
Brome			A	A	
Prairie dropseed					C
Wild barley					C
Fowl bluegrass					C
Wetland sedges					C
Shrubs					
Prairie rose	A				
Western snowberry		D	D	A	A
Wolf willow (silverberry)		D			
Woods rose		A	A		
Chokecherry				D	
Saskatoon berry				D	
Trees					
Trembling aspen			D		
Green ash				D	
American elm				A	
Manitoba maple				A	

*D: Dominant Species
A: Associated Species
C: Common Species (no clear dominance is apparent due to high degree of variability).

The grass-meadow-wetland (or slough) complex varies considerably in species composition from one area to another. The drier part resembles the upland grass types described above. The moister areas support a meadow vegetation consisting mainly of prairie dropseed (*Sporobolus heterolepis*) or Kentucky bluegrass (*Poa pratensis*) in addition to the more mesophytic elements of the upland (e.g. green needlegrass, *Stipa viridula* and western porcupine grass). Species common in the wetter parts of this complex include fowl bluegrass (*Poa palustris*), wild barley (*Hordeum jubatum*) and wetland sedges (*Carex spp.*).

The riparian forest associated with the Souris River flood plains is highly diverse and is dominated by green ash (*Fraxinus pennsylvanica*) with an understory dominated by the medium-tall shrubs: chokecherry (*Prunus virginiana*) and Saskatoon berry (*Amelanchier alnifolia*).

The forest in the grass-shrub-aspen complex is dominated by aspen (*Populus tremuloides*) with an understory largely consisting of western snowberry or Kentucky bluegrass. Grass yield under aspen is extremely low.

A very small proportion of the area appears to have been broken and seeded or abandoned in the past. Secondary succession has taken place and the present vegetation generally resembles that of nonbroken areas with the exception of the greater forb or weedy component and the presence of introduced forage species such as crested wheatgrass (*Agropyron cristatum*).

3.4 Range Sites

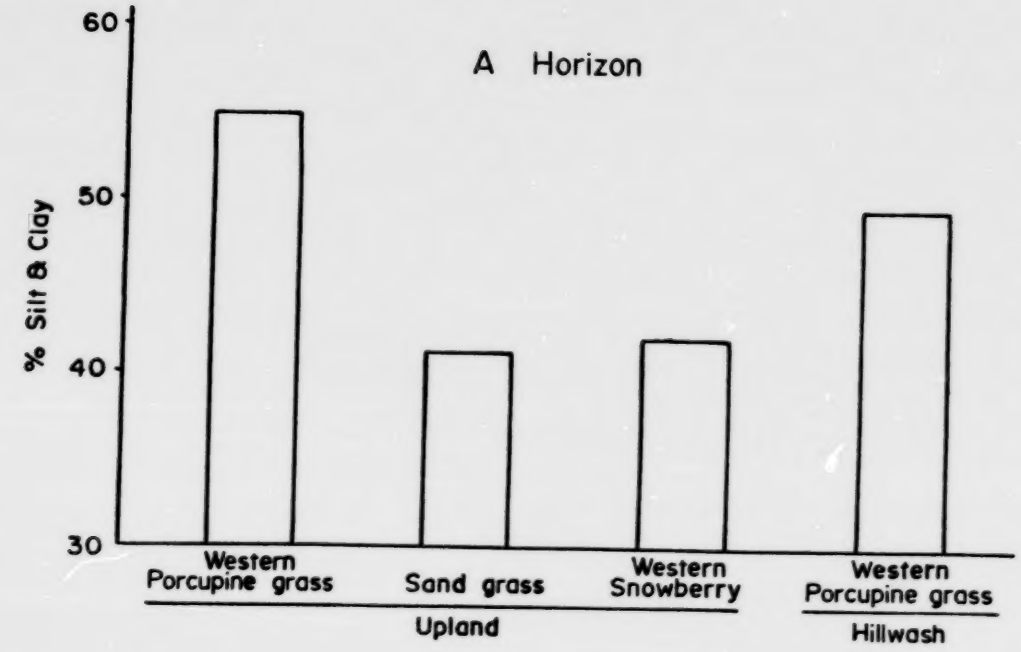
Examination of undisturbed upland grass relicts (Figure 2.2) revealed the presence of two range sites differentiated on the basis

of the kind of dominant plant species and the proportion of the most important species. These are Loamy and Sandy Range Sites. The two sites occur intermingled as a mosaic and, hence, are difficult to map. A description of the two sites is given in Appendix C-8. The Loamy Site is more extensive and is dominated by western porcupine grass which constitutes an estimated average of 40% of the total yield. The Sandy Site is dominated by sand grass where it contributes an estimated average of 50% of the total yield. Within these sites shrubs are of minor importance and are usually restricted to depressions and occupy a very small area.

Further examination of the results of the soil analyses (Appendix C-9) appears to support the above differentiation of range sites. Of particular importance are the differences in the proportion of fine (silt and clay) soil material (Figure 3.3). Soils supporting sand grass contain smaller proportions of fine material than those under other types of vegetation. The differences in the B horizon are particularly significant.

3.5 Range Condition

In view of the absence of a range condition guide for southeastern Saskatchewan, an attempt was made to construct a specific guide for the pasture area (Table 3.7). The constructed guide is a modification of the Alberta Range Condition Guide (Smoliak *et al*, 1976a) on the basis of observations from relict grasslands in the study area



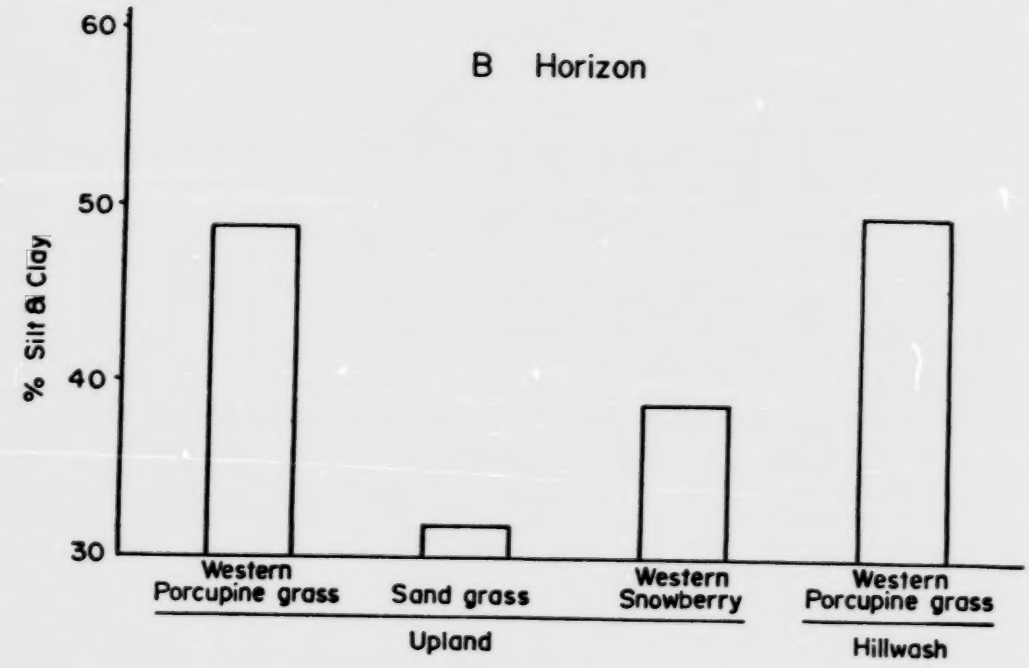


Figure 3.3 The Proportion of the Fine Mineral Material in the Soils under the Various Vegetation Types

Table 3.7 Classification of Some Vascular Plant Species Found in the Coalfields Community Pasture According to their Response to Grazing by Cattle.

A DECREASERS (Species known to decrease under continued heavy grazing. Included in the calculations of range condition in any amount found.)

(1) Loamy Site*

Western porcupine grass (*Stipa spartea* var. *curtiseta*)
Green needlegrass (*S. viridula*)
Bearded wheatgrass (*Agropyron subsecundum*)
Western wheatgrass (*A. smithii*)
Northern wheatgrass (*A. dasystachyum*)
Hooker's oatgrass (*Helictotrichon hookeri*)
Rough fescue (*Festuca scabrella*)
Little bluestem (*Andropogon scoparius*)
Prairie dropseed (*Sporobolus heterolepis*)
Switch grass (*Panicum virgatum*)

(2) Sandy Site

Western porcupine grass
Needle-and-thread (*Stipa comata*)
Western wheatgrass
Bearded wheatgrass
Hooker's oatgrass

*For description of range sites refer to Appendix C-8.

Table 3.7 (Continued)

B INCREASERS (Species known to increase at least initially under continued heavy grazing. Included in the calculation of range condition up to the maximum specified below.)

Species	Maximum Percentage Under Excellent Range Condition	
	Loamy Site	Sandy Site
Sand grass (*Calamovilfa longifolia*)	5	55
Blue grama (*Bouteloua gracilis*)	5	5
Junegrass (*Koeleria cristata*)	5	5
Needle-and-thread (*Stipa comata*)	10	20
Kentucky bluegrass (*Poa pratensis*)*	5	5
Salt grass (*Distichlis stricta*)	5	5
Mat muhly (*Muhlenbergia richardsonis*)	5	5
Upland sedges (mainly *Carex filifolia*, *Carex pensylvanica* and *C. eleocharis*)	10	5
Woody species (mainly western snowberry *Symphoricarpos occidentalis*, wolf willow *Elaeagnus commutata*)	5	5
Forbs (mainly pasture sage *Artemisia frigida*)	10	5

*not considered as part of the natural mixed prairie grassland.

C INVADERS (Normally not found in any significant amount under climax condition but are introduced or increased as a result of continued heavy grazing. None of these species are included in the calculation of range condition. The list applies to both Sandy and Loamy Sites.)

Sheep fescue (*Festuca ovina*)*
Hair grass (*Agrostis scabra*)
Gumweed (*Grindelia squarrosa*)
Broomweed (*Gutierrezia sarothrae*)
Foxtail barley (*Hordeum jubatum*)
Dandelion (*Taraxacum officinale*)
Canada thistle (*Cirsium arvense*)

*Considered as a decreaser in Alberta.

(Section 3.4). The constructed guide differs from the Alberta Guide in that:

(1) it allows the inclusion of sand grass up to a maximum of 5% in Loamy Sites and 55% in Sandy Sites as judged from relict areas. According to the Alberta Guide sand grass is not part of the natural vegetation on Loamy Sites and allowed only 10% in Sandy Sites

(2) it treats Kentucky bluegrass as an increaser rather than an invader as indicated in the Alberta Guide. Kentucky bluegrass was present in relict areas (although in small amounts, < 1%). Some deviation from the climax may be recommended to ensure a practicable management goal.

(3) it considers sheep fescue as an invader on the basis of our observations and not a decreaser as is the case in Alberta.

Generally, the guide used in the present study appears to represent a compromise between the Alberta Range Condition Guide and the North Dakota Range Condition Guide (U.S. Soil Conservation Service 1975).

Range condition varies both between and within fields (Table 3.8, Figure 3.4 and Appendices C-10 and C-11). The overall condition rating for the predominant range site (Loamy) ranged from 51 (Class B, Good; see Table 2.1) in field number A3 to 77 (Class A, Excellent) in field number A4. This means a significant deviation from the potential composition and productivity in the former and a satisfactory range condition in the latter. Only two fields (A4 and C1a) were shown to have a satisfactory range condition (Class

Table 3.8 Summary of Range Condition Ratings (%).

Field No.	Loamy Site		Sandy Site	
	Range	Weighted Average	Range	Weighted Average
A3	32 - 66	51	54 - 93	68
A4	53 - 92	77	72 - 84	76
A4a	52 - 61	55	44 - 89	71
B1	59 - 68	64	75 - 98	84
B1a	49 - 59	55	73 - 89	82
B2	56 - 82	72	80 - 87	84
B2a	48 - 66	58	60 - 65	63
B2b	53 - 67	59	74 - 87	79
B2c	64 - 74	68		
B3	38 - 71	58	65 - 80	75
B4	57 - 69	62	73 - 77	74
C1	49 - 81	67	55 - 82	76
C1a	70 - 81	76	70 - 75	73
C2	45 - 77	55	55 - 83	79
C3	68 - 71	69	85	85
C5	55 - 75	63	60 - 89	75
C6	48 - 94	67	87 - 90	89
C6a	46 - 69	62	63 - 87	81
D1	46 - 87	59	68 -100	77
D1a	52 - 65	59	58 - 98	79
D2	46 - 71	54	65 - 78	72
D2a	52 - 91	73	72 - 95	83

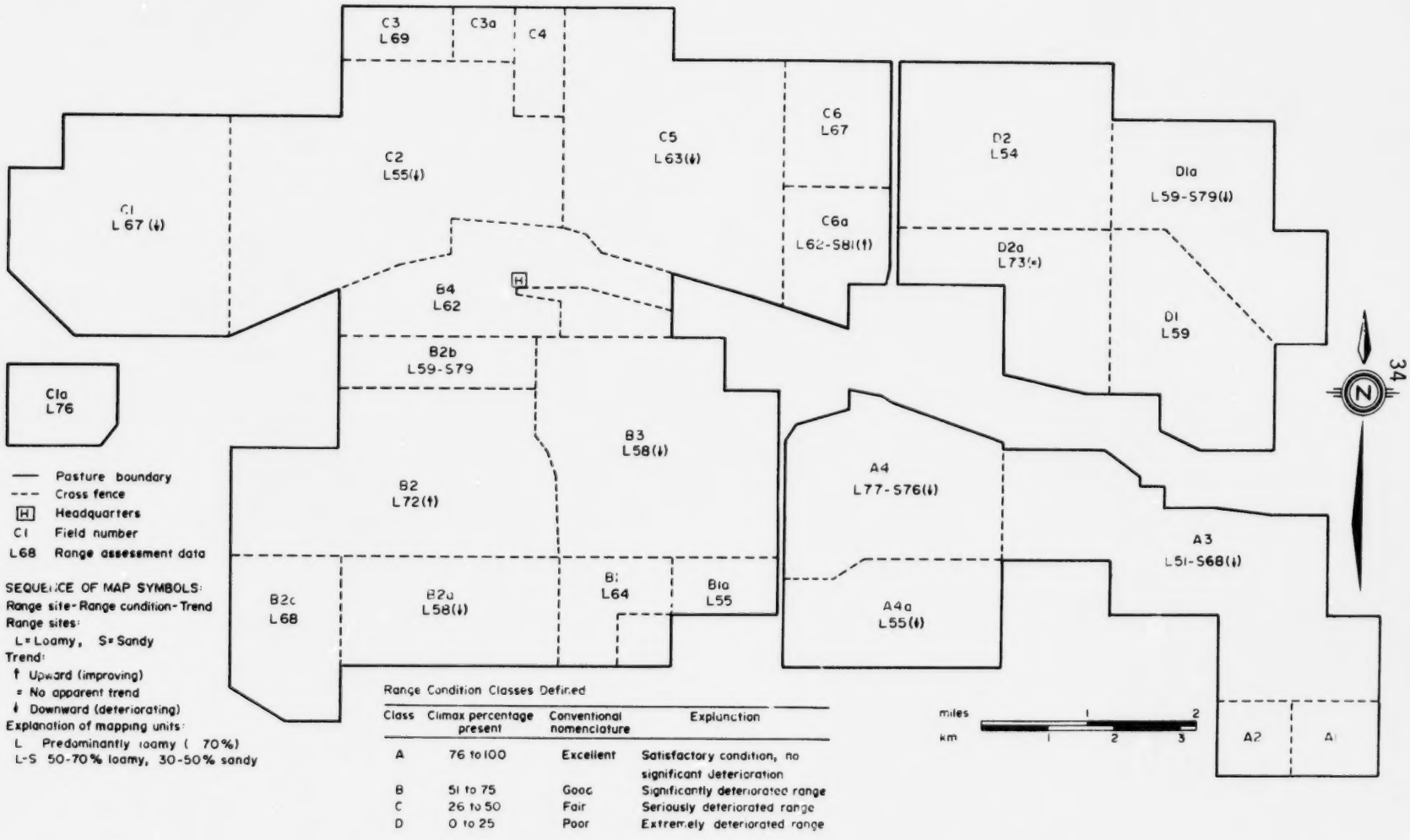


Figure 3.4 Range Conditions and Trend of the Major Fields in the Study Area (the absence of condition or trend data means that the field was not surveyed for these parameters).

A, Excellent). The noted deterioration in range condition in the remaining fields is likely a result of prolonged periods of over-use (Section 3.10).

The wide range of condition ratings within some of the fields appears to be a reflection of differences in grazing distribution patterns (resulting from such factors as topography and distance to watering points) and plant community characteristics. The highly dissected nature of the areas mapped as Hillwash (e.g. B2 and B3) resulted in substantial variations in grazing pressures. Loamy Sites are dominated by the highly palatable western porcupine grass which is also sensitive to overgrazing. Sandy Sites are dominated by sand grass which is less palatable and less sensitive to grazing than western porcupine grass. The presence of the sites in an intermingled pattern produced a mosaic of range conditions.

The areas with range condition ratings below the satisfactory class (Class A, Excellent) often contain excessive amounts of pasture sage, other forbs (such as goldenrod, *Solidago rigida*), low upland sedges or shrubs (Figure 3.5, Appendices C-6, C-7).

3.6 Trend in Range Condition

Range condition classification (Section 3.5) indicates the present condition but does not evaluate whether a range is deteriorating or improving. Trend surveys give an indication of the direction of change in range condition.

The apparent trend in soil condition as determined from consideration of litter accumulation, erosion and rodent activities (Section 2.5)

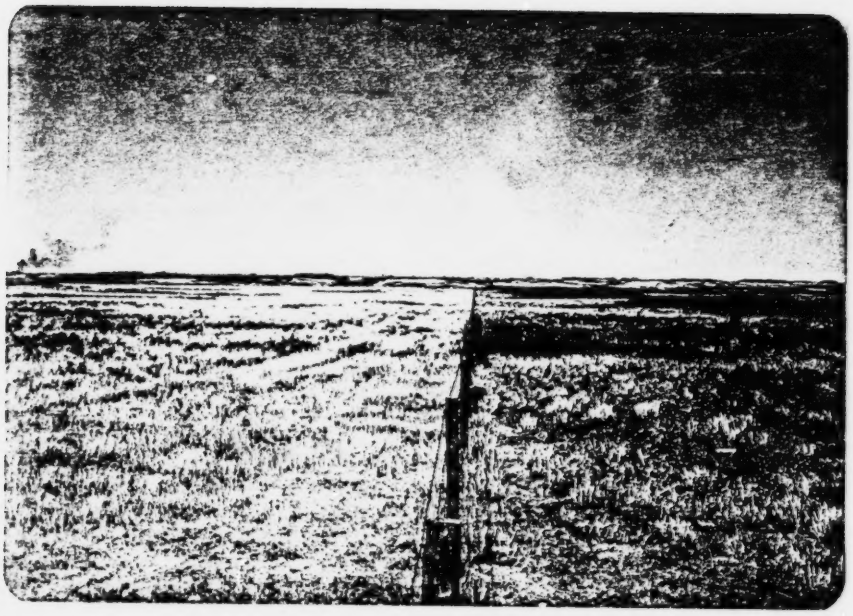


Figure 3.5 Examples of Areas in Different Range Condition Classes. The area to the Left Represents a Range in the Upper Good Range Condition Class (Class B), While the Area Across the Fence is a Typical Example of Areas in the Fair Range Condition Class (Class C).

is generally upward (Table 3.9). This is perhaps a reflection of the generally reduced stocking rates in recent years (Section 3.10). Also, the abundant standing dead and litter material produced by the slightly grazed Sandy Sites appears to provide a degree of protection from erosional forces.

The overall vegetation trend analysis shows a very slight downward change (Table 3.10, Figure 3.4). A slight downward trend is noted for all parameters with the exception of vigor where a minor upward trend is apparent. A few fields showed no change or a slight upward trend.

Although climatic conditions, particularly precipitation, influence trend, the downward trend observed is likely to have been induced by overgrazing since differences in trend were noted between adjacent fields (Figure 3.4).

3.7 Browse Condition

Most of the upland in the pasture area consists of a mosaic of grass and low-shrub vegetation types considered of low capability as a habitat for white-tailed deer. However, the forested areas associated with the Souris River Valley and the highly dissected areas along the valley provide better habitat. Therefore, a reconnaissance browse condition survey was attempted at three locations along the valley to assess possible wildlife-livestock utilization interactions. Western snowberry and wolf willow were selected for the survey. Both are important browse species for white-tailed deer. Western snowberry, however, is generally more abundant in the area than wolf willow.

The overall rating (based on the combined data for the three locations surveyed) of the relative condition of the western snowberry showed only slightly greater hedging and lower vigor inside than

TABLE 3.9 Trend in Soil Condition in the Coalfields Community Pasture - 1981.

Field	Parameters*			
	Litter Accumulation	Erosion/ Bare Soil	Rodent Activity	Overall Trend
A3	+1.5	+2	+1	+4
A4	+1.5	+2	+1	+4
A4a	+1.5	+2	+1	+4
B2	+1.7	+2	+1	+5
B2a	+1.5	+2	+1	+4
B3	+2.2	+2	+1	+5
C1	+1.5	+2	+1	+4
C2	+0.8	+2	+1	+4
C5	-3.0	+2	+1	+2
C6	0	+2	+1	+3
D1a	+3.0	+2	+1	+4
D2	-0.5	+2	+1	+3
D2a	+1.5	+2	+1	+4
Average	+1	+2	+1	4

*Scale used in rating (see Appendix B-4 for details):

Litter accumulation	-3 to +3
Erosion/bare soil	-2 to +2
Rodent activity	-1 to +1

Explanation of trend direction:

+ Upward (improving)

- Downward (deteriorating)

0 No apparent change

Table 3.10 Trend in Vegetation Condition in the Coalfields Community Pasture - 1981.

Field	Parameters*				Overall Trend
	Reproduction	Browse	Standing Dead	Vigor	
A3	-1.5	+0.8	-1.0	-1.2	-3
A4	-1	-1.2	-0.5	-0.8	-3
A4a	-1	-1.5	-0.5	0	-3
B2	+0.5	-0.2	+0.8	+0.8	+2
B2a	-0.5	-1.5	-0.5	+1.2	-1
B3	-0.5	0	-0.5	+1.5	+1
C1	-1.5	-0.7	-1.0	-1.0	-4
C2	-1.5	-0.7	-1.0	0	-3
C5	-0.5	-2.0	-2.0	-1.0	-5
C6	0	-2.0	-2.0	0	-4
D1a	0	+1.5	+0.5	+1.5	+3
D2	-1	0	0	0	-1
D2a	+1	-1.5	0	+0.5	0
Average	-0.6	-0.7	-0.6	+0.1	-2

*Scale used in rating (see Appendix B-4 for details):

Reproduction	-2 to +2
Browse	-2 to +2
Standing dead	-2 to +2
Vigor	-2 to +2

Explanation of trend direction:

+ Upward (improving)

- Downward (deteriorating)

0 No apparent change

outside the pasture (Table 3.11). However, variations between locations are apparent. Very similar ratings have been indicated inside and outside the pasture for both the "age classes" and "dead twigs" parameters.

The overall rating of the relative condition of wolf willow showed slightly greater hedging and more dead twigs outside than inside the pasture. The ratings for "age class" and "vigor" were essentially the same inside and outside the pasture (Table 3.12).

3.8 Yield

Yield (maximum standing crop) represents a minimal estimate of net above-ground primary production. Primary production is influenced by many factors including type of vegetation, range condition, site characteristics and current weather conditions (mainly amount and distribution of precipitation). In the present study, only one year's data have been obtained (Table 3.13 Appendix C-12). Locations selected for yield sampling represent upland range sites (Section 3.4) judged to be in "excellent" (Class A) or upper "good" (Class B) range condition classes (Section 3.5).

Although the total yield was similar for the three vegetation types sampled, the graminoid yield was significantly lower (Table 3.13, Appendix C-13) in the snowberry (*Symphoricarpos*) type than in the western porcupine grass (*Stipa*) and sand grass (*Calamovilfa*) types. Graminoids contribute only 61% of the total yield in the snowberry type compared to 87% and 90% for western porcupine grass and sand grass types, respectively. The proportion contributed by forbs (broad-leaved

Table 3.11 Browse Condition in Selected Fields in the Coalfields Community Pasture and in Adjacent Areas Outside the Pasture- Western Snowberry (*Symphoricarpos occidentalis*). Condition Rating is Given for each Condition Class*.

Field Location	Hedging			Age Classes			Dead Twigs			Vigor			Total Score
	Not Evident (+2)	Moderate (+1)	Severe (-2)	Adequate (+2)	Some (+1)	Little or None (-2)	Normal (+2)	Moderate (+1)	High (-2)	High (+2)	Medium (+1)	Low (-2)	
C2													
Inside		2	-4	8				3	-2		3		10
Outside		1	-6	6	1			2	-4		3		3
CGa													
Inside		2	-8	10				2	-8		3	-4	-3
Outside		4	-4	12				2	-8	6	2		14
D1													
Inside		5	-2	12				4	-4		4	-4	15
Outside		6		10	1		4	2	-4	2	5		26
Overall													
Inside		9	-14	30				9	-14		10	-8	22
Outside		11	-10	28	2		4	6	-16	8	10		43
Total													
Inside		-5			30			-5			2		22
Outside		1			30			-6			18		43

*See Appendix B-7 for details.

Table 3.12 Browse Condition in Selected Fields in the Coalfields Community Pasture and in Adjacent Areas Outside the Pasture - Wolf Willow (*Elaeagnus commutata*). Condition Rating is Given for each Condition Class*.

Field Location	Hedging			Age Classes			Dead Twigs			Vigor			Total Score
	Not Evident (+2)	Moderate (+1)	Severe (-2)	Adequate (+2)	Some (+1)	Little or None (-2)	Normal (+2)	Moderate (+1)	High (-2)	High (+2)	Medium (+1)	Low (-2)	
C2													
Inside		2	-4	8				3	-2	2	2		11
Outside			-8	6	1			2	-6		2		-1
C6a													
Inside		2	-2	6			2	1	-2		2		9
Outside		2	-2	4	1			2	-2	2	1		6
D1													
Inside		2	-2	6			2	1	-2	2	2		11
Outside		1	-4	4	2				-6	2	2		3
Overall													
Inside		6	-8	20			4	5	-6	4	6		31
Outside		3	-14	14	4			4	-12	4	5		10
Total													
Inside		-2			20			3			10		31
Outside		-11			18			-8			9		8

*For more details see Appendix B-7.

Table 3.13 Average Maximum Standing Crop in the Main Range Types

	Field No.	$\bar{x}$ wt. g/0.25 m^2				Composition		
		Graminoids	Forbs	Shrubs	Total	Graminoids	Forbs	Shrubs
Stipa	B2	35.5	6.5	1.5	43.5			
	B4	45.9	4.0	0.8	50.7			
	C1a	47.0	3.3	1.0	51.4			
	C2	39.2	8.4	0.6	48.1			
	C6	38.5	2.0	2.1	42.5			
Average		41.2	4.8	1.2	47.2	87	10	3
Calamovilfa	B2	53.3	4.8	2.8	61.0			
	B4	50.0	5.8	1.4	57.2			
	C1a	45.2	2.4	0.1	47.8			
	C2	47.5	2.7	1.5	51.7			
Average		49.0	3.9	1.5	54.4	90	7	3
Symphoricarpos	B2	29.4	4.8	11.9	46.0			
	B4	34.8	12.3	11.5	58.6			
	C1a	30.1	4.7	14.0	48.9			
	C2	26.9	T	17.2	44.1			
Average		30.3	5.5	13.6	49.4	61	11	28
Overall Average		40.2	4.7	5.4	50.3	79	10	11

herbs) was similar (7 - 11%) in the three types. Shrubs contributed a very small proportion (3% or less) of the total yield in the western porcupine grass and sand grass types as compared to 28% in the snowberry type.

Within the same vegetation type, no significant differences were found in graminoid yield between the different locations sampled.

The yield values obtained in the present study are comparable to those reported for the moister years in other mixed prairie locations in Saskatchewan (Coupland, 1974; Smoliak *et al.*, 1976b). Although the precipitation in the area was slightly lower than normal for June and July 1981, the August precipitation greatly exceeded the normal (Environment Canada, 1981).

Various regression equations relating yield to growing season precipitation have been developed. The use of equations developed by Smoliak *et al.* (1976b) and Looman (1981) yielded two similar values approaching 700 kg/ha (70 g/m^2) when long-term precipitation averages (Section 3.1) were used. On the basis of the above-mentioned equations and the 1981 precipitation data (Environment Canada, 1981), the predicted yield for 1981 is estimated to be 545 to 560 kg/ha (54.5 to 56.0 g/m^2). These values appear to be extremely low compared to the actual yield data obtained in the present study (1890 to 2180 kg/ha). This is, perhaps, due to the fact that the equations used were developed on the basis of data mainly from the Swift Current area where the precipitation/evaporation

ratio is likely to be smaller than that for the study area. Chakravarti (1969) included the study area in the Dry Subhumid Moisture Region, while Swift Current was placed in the Semiarid Region.

3.9 Utilization

Due to the lack of practical utilization guides suitable for the area, an attempt was made to construct one. Western porcupine grass was considered the main key species in the area because of its palatability and its substantial contribution to the total yield (Sections 3.3 and 3.4). Therefore, it was selected for the preparation of a tentative guide (Figure 3.6). The verification data collected (Section 2.8) appear to yield consistently lower utilization levels than the guide. However, the guide data showed very little variations particularly in the first three height increments (standard error expressed as percentage of the mean was between 5.4 and 6.7). Consequently, no attempt was made to adjust the guide. This should not affect the results since the main purpose of the utilization survey was to gain an insight into the utilization patterns in the various fields.

Percentage utilization of the key species showed generally wide variations both within and between fields (Table 3.14). The stands surveyed in fields B2, C1 and C2 were located on upland areas where underutilization was suspected on the basis of observations made during the range condition survey. The utilization survey appears to confirm these observations. The main reason for the

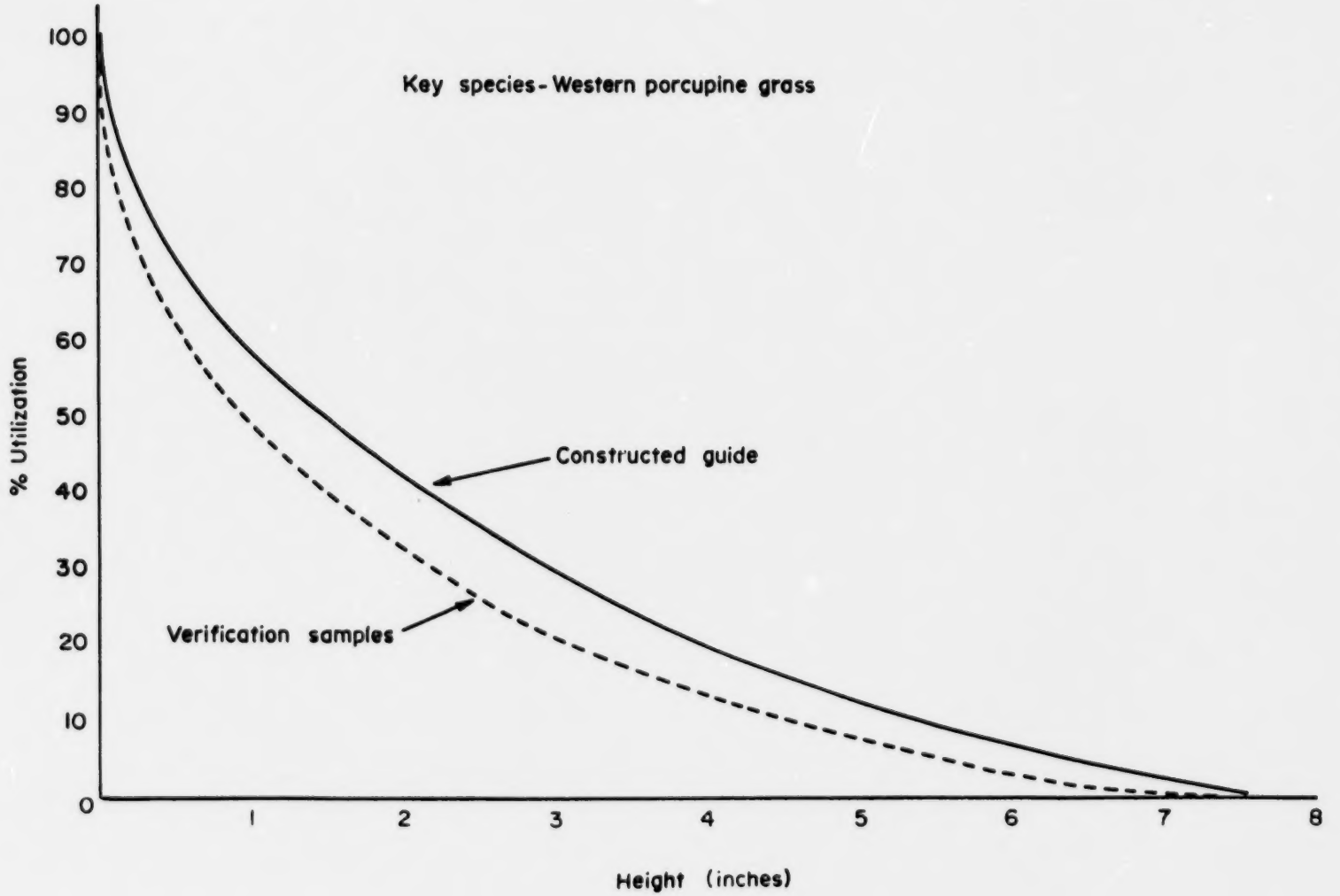


Figure 3.6 The Tentative Utilization Guide Constructed and Used in the Present Study.

Table 3.14 Summary of Key Species (Western Porcupine Grass) Utilization Data - September 2-3, 1981.

Field No.	Height (inches)		% Utilization	
	Range of Means*	Average	Range	Average
A3	2.1 - 3.5	2.8	23 - 41	32
A4	1.9 - 4.1	3.1	17 - 44	27
B2	4.0 - 7.0	5.1	3 - 18	10
B3	1.1 - 1.9	1.5	44 - 58	49
C1	1.8 - 6.3	3.8	4 - 45	18
C2	3.0 - 5.5	4.2	7 - 28	11
C5	1.3 - 1.9	1.6	44 - 56	48
D1a	1.5 - 3.8	2.2	20 - 49	40
D2	1.6 - 4.1	2.5	17 - 48	34

*for ten locations within each field

light utilization of these areas appears to be the tendency for cattle to spend substantially more time grazing on coulee bottoms and lower slopes. It should be noted also that watering points in these areas are located in coulees.

The locations surveyed in the remaining fields are considered as key areas (i.e. utilization data from these areas can be used to judge the utilization of the entire field). The average utilization in these fields ranged from 27 to 48%. Even in areas where topography is favourable, substantial variations in utilization are apparent (e.g. Field no. D2). These variations are likely to be related to variations in such factors as distance to watering points, salting grounds, etc. It was noted that salt blocks and oilers are generally located near watering points, a practice which often leads to unacceptable (excessive) "sacrifice" areas.

Assuming a proper use of 45% for the key species (U.S. Forest Service, 1977), the data show that the proper use level has already been exceeded in two fields (B3 and C5) by September 2 or 3. Holscher and Woolfolk (1953) indicated that the proper utilization of needle-and-thread, a close relative to but less vigorous than porcupine grass, is attained when a stubble of 5 cm (2") was left. It is interesting to note that using the stubble height of needle-and-thread as a criterion indicated also that the proper utilization level was exceeded in the above-mentioned fields. Furthermore, according to the guide used in the present study, a 5 cm stubble means a utilization of approximately 42%, a remarkably similar value to that recommended by the U.S. Forest Service (1977) for key species in ranges with good to excellent conditions.

3.10 Grazing Capacity and Stocking Rates

An examination of the available literature yielded the following grazing capacity estimates for the pasture area:

(1) 0.92 to 1.2 ha/AUM (Animal Unit Month). This was based on a grazing capacity map prepared by Smoliak *et al.* (1976b).

(2) 0.91 ha/AUM. This was based on a regression equation employing long-term precipitation average for the April to July period (see Section 3.1) to obtain yield estimates (Smoliak *et al.*, 1976b). A carry-over of 45% was allowed in the calculations.

(3) 0.91 ha/AUM. This was based on a regression equation employing the long-term precipitation average (in excess of 25 mm) for the May to June period (Looman, 1981). The carry-over allowed is similar to that used in No. (2).

(4) 0.81 ha/AUM. This was based on the recommended stocking rates for sandy and loamy range sites in excellent range condition as given in the Alberta Range Condition Guide for the 356 mm (14") to 457 mm (18") precipitation zone (Smoliak *et al.*, 1976a).

Actual stocking rates data are available for most fields for more than 20 years (Figure 3.7, Appendix C-15). The average rates were highest during the period from 1963 to 1977 and ranged from 0.73 to 0.87 ha/AUM (or 0.66 to 0.78 ha/AUM on the basis of usable range area only, Table 3.15). These rates appear to explain the decline in range condition and the downward trend in most fields surveyed in the present study and provide an indication that these

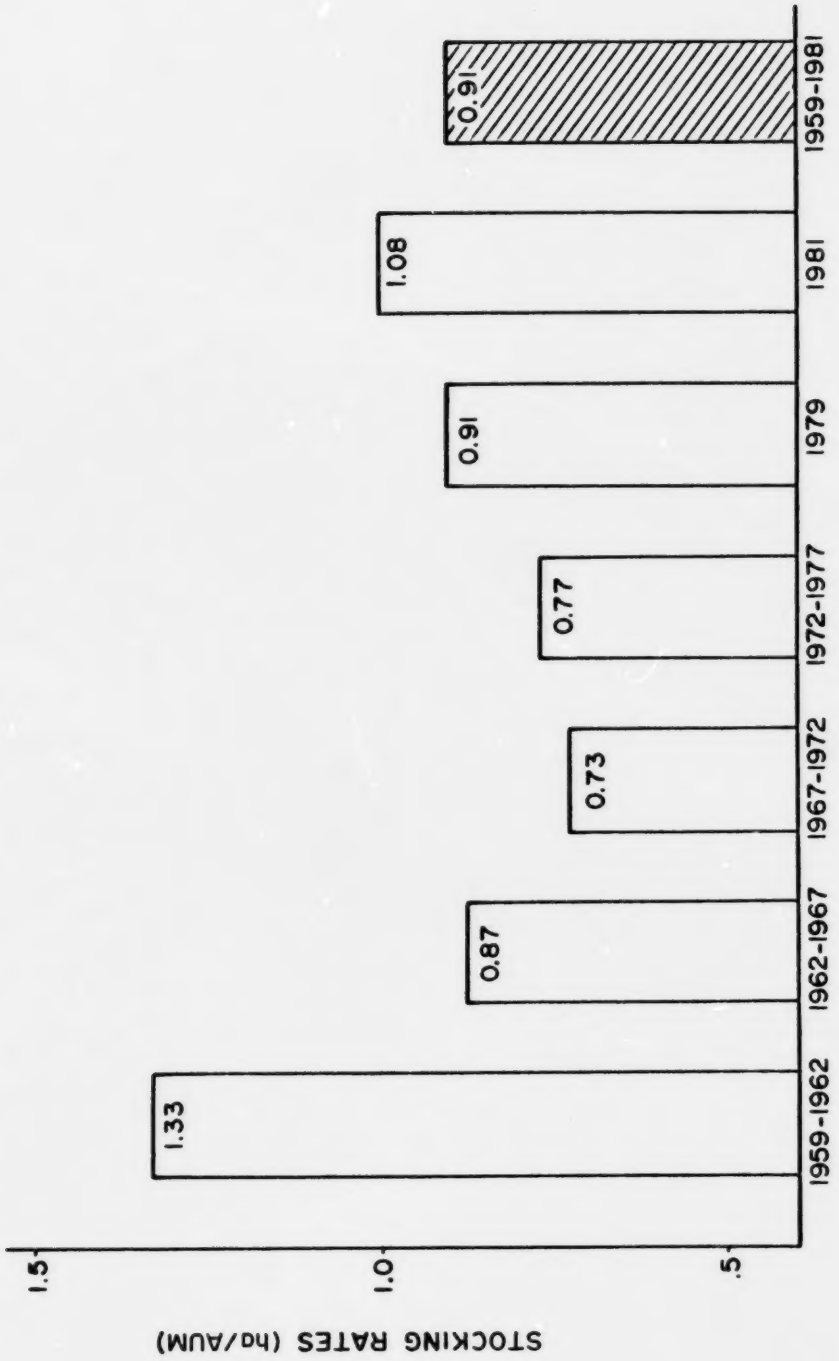


Figure 3.7 Average Actual Stocking Rates for Coalfields Community Pasture (1959-1981).

Table 3.15 Areal Extent (ha) of Useable Rangeland in the Coalfields Community Pasture.*

Field Number	Total Area	Useable Range**		
		Loamy Sites	Sandy Sites	Total
A3	1,109	692	406	1,098
A4	782	493	289	782
A4a	502	94	26	120
B1	194	132	37	169
B1a	130	89	38	127
B2	956	803	153	956
B2a	518	339	18	357
B2b	219	113	93	206
B2c	380	380		380
B3	1,052	682	265	947
C1	939	826	113	939
C1a	194	180	11	191
C2	1,303	650	183	833
C3	130	126	4	130
C5	1,133	1,008	125	1,133
C6	299	239	60	299
C6a	284	142	142	284
D1	601	493	108	601
D1a	669	501	103	604
D2	778	698	52	750
D2a	501	451	50	501
	12,673	9,144	2,278	11,422

*A number of smaller fields (mainly holding fields) are not included.

**Useable rate area = total area of the field - area of dense shrubs or aspen (as shown in Table 3.5).

rates may have been excessive. The values indicated under no. (1) (0.92 to 1.20 ha/AUM) appear to underestimate the grazing capacity mainly because the area is located in the transition zone between the Mixed Prairie and Parkland Regions (see also Section 3.8). The more appropriate grazing capacity, therefore, appears to be an intermediate value between the average actual stocking rates and the value recommended by Smoliak *et al.*, 1976b (estimate no. 1). This lead to the selection of estimate no. 4 (0.81 ha/AUM, usable-range basis) for estimating grazing capacity for the dominant range site (loamy). A rate of 1.62 ha/AUM was arbitrarily selected for Sandy Range Site to correct for the low palatability of the dominant species (sand grass).

Usable range area was determined for each of the major fields (Table 3.15). This involved subtracting the areas supporting dense shrub or tree cover from the total area of the field. These areas produce negligible graminoid yield and are generally avoided by cattle. The estimated grazing capacity is given in Table 3.16. A utilization cut of 33% was applied to the Hillwash areas where unfavourable topography appears to reduce utilization substantially (Table 3.14). The overall carrying capacity varies considerably between fields (0.81 to 3.8 ha/AUM, usable-area basis). The overall average for the pasture is 1.09 ha/AUM (total-area basis).

Grazing capacity estimates indicated above are applicable to areas in excellent range condition (Class A). Recommended stocking rates take into consideration present range condition to allow for

Table 3.16 Estimated Carrying Capacity of the Various Fields in the Coalfields Community Pasture*.

Field Number	Carrying Capacity (AUM)					Overall Carrying Capacity (ha/AUM)
	Loamy Sites	Sandy Sites	Total Carrying Capacity	Utilization Cuts (topography)	Corrected Carrying Capacity	
A3	854	251	1,105	162	943	1.18
A4	609	178	787	223	564	1.39
A4a	116	16	132		132	3.80
B1	163	23	186		186	1.04
B1a	110	23	133		133	0.98
B2	991	94	1,085	187	898	1.06
B2a	419	11	430		430	1.20
B2b	140	57	197		197	1.11
B2c	469		469		469	0.81
B3	842	164	1,006	172	834	1.26
C1	1,020	70	1,090	103	987	0.95
C1a	222	7	229		229	0.85
C2	802	113	915	58	857	1.52
C3	156	2	158		158	0.82
C5	1,244	77	1,321	32	1,289	0.88
C6	295	37	332		332	0.90
C6a	175	88	263	16	247	1.15
D1	609	67	676	22	654	0.92
D1a	619	64	683	24	659	1.02
D2	862	32	894		894	0.87
D2a	557	31	588	33	555	0.90
	11,290	1,406	12,696	1,032	11,664	1.09

*A number of smaller fields, mainly holding fields, are not included.

range recovery. The following rates were used in the present study:

Range Condition	Recommended Stocking Rates (ha/AUM)	
	Loamy Sites	Sandy Sites
Class A (Excellent)	0.81	1.62
Class B (Good)	1.01	2.02
Class C (Fair)	1.34	2.68
Class D (Poor)	2.02	4.02

The recommended stocking rates are given in Table 3.17. The rates range from 0.85 ha/AUM to 4.74 ha/AUM depending on field. The overall average for the pasture is 1.36 ha/AUM. The total stocking rate recommended at present is estimated to be 9316 AUM (or 1863 AU/5-month grazing season). This represents a reduction of approximately 20% from the overall average stocking rate for the 1981 grazing season.

Table 3.17 Recommended Stocking Rates for the Various Fields in the Coalfields Community Pasture*.

Field Number	Stocking Rates (AUM)		Utilization Cuts (AUM)	Recommended Stocking Rate		Overall Stocking Rate (ha/AUM)
	Loamy Sites	Sandy Sites		AUM	AU/5 month season	
A3	685	34	162	557	111	1.99
A4	609	178	223	564	113	1.39
A4a	93	13		106	21	4.74
B1	131	23		154	31	1.26
B1a	88	23		111	22	1.17
B2	795	94	187	702	140	1.36
B2a	336	9		345	69	1.50
B2b	112	57		169	34	1.30
B2c	376			376	75	1.01
B3	675	131	172	634	127	1.66
C1	818	70	103	785	157	1.20
C1a	222	7		229	46	0.35
C2	644	113	58	699	140	1.86
C3	125	2		127	25	1.02
C5	998	62	32	1,028	206	1.10
C6	237	37		274	55	1.09
C6a	141	88	16	213	43	1.33
D1	488	67	22	533	107	1.13
D1a	496	64	24	536	107	1.25
D2	704	27		731	146	1.06
D2a	447	31	33	445	89	1.13
	9,220	1,130	1,032	9,318	1,864	1.36

*A number of smaller fields used mainly as holding fields are not included.

4. SUMMARY AND CONCLUSIONS

4.1 Introduction

The main objective of the present study was to provide a biophysical inventory and a range condition assessment of the Coalfields Community Pasture area. The study consisted of field investigations conducted during the 1981 growing season as well as examination and interpretation of recent air photos and available published and unpublished information.

The first step in the approach employed in the present study consisted of identification and description of range sites and range types. This was followed by an evaluation of range condition and trend. Then, grazing capacity estimates were made on the basis of range site and plant community characteristics, past-use history and available literature. Finally, the recommended stocking rates were derived from the grazing capacity estimates after adjustments were made for the present range condition.

4.2 Climate

The climate of the area is classified as cold, dry, subhumid. The mean annual precipitation is estimated to be 410 mm, two-thirds of which falls during the May to September growing period.

4.3 Soils

The soils of the study area are predominantly Dark Brown Chernozemic largely developed in glacial till. Sandy loam, loam and sandy clay loam are the dominant soil textural classes in the area. Topography generally ranges from moderately undulating to moderately rolling.

Most of the soils of the pasture area have been placed in Classes 5 and 6 according to the soil capability classification for agriculture. Soils in these classes are capable only of producing perennial forage crops. The main limitations include insufficient soil moisture holding capacity, excess stoniness and unfavourable topography.

The organic C and total N in the soils of the area are comparable to or greater than that of similar soils under native mixed grass vegetation. However, available N and P appear to be generally low.

4.4 Flora and Vegetation

A total of 108 species of vascular plants have been encountered in the pasture area during the present study. No primary stock-poisoning plants were found. Leafy spurge (*Euphorbia esula*), a persistent introduced forb, was found in small patches in the area (field A4). Although some reports consider leafy spurge poisonous to livestock (Mitich *et al.*, 1962; Frankton and Mulligan, 1970), no losses resulting from its consumption have been reported from Western Canada (Lodge *et al.*, 1968). The weed is very low in palatability and would not be consumed by cattle unless pasture "condition" is very poor.

The study area is located in the transition zone between the Mixed Prairie Grassland and the Parkland Region of the province. The vegetation is largely a mosaic of grass and shrub types. Predominantly grass types cover 57% of the pasture area, while

predominantly shrub types occupy 29% of the area. Other minor types include shrub-grass-aspen and grass-meadow-wetland complexes. The most important range types in terms of areal extent are the western porcupine grass (*Stipa spartea* var. *curtiseta*) type, the sand grass (*Calamovilfa longifolia*) type and the western snowberry (*Symphoricarpos occidentalis*) type.

4.5 Range Sites

The study area has been classified as a complex of Loamy and Sandy Range Sites. Loamy Sites occupy the largest proportion of the area.

Under climax condition (or excellent range condition) Loamy Range Sites are dominated by western porcupine grass which contributes an average of 40% of the total potential yield. The Sandy Range Site is dominated by sand grass which contributes an average of 50% of the total yield. Within these sites, shrubs constitute a minor proportion of the climax vegetation and are usually restricted to depressions and occupy very small areas.

4.6 Range Condition and Trend

Because of the lack of range condition guides suitable for the area, the Alberta Range Condition Guide was used after modifications based on site-specific data collected during the present study.

Range condition varied both between and within fields. The overall condition rating for the predominant range site (Loamy) ranged from 51% (Class B, Good) to 77% (Class A, Excellent). However, only two fields were shown to have a satisfactory range condition

(Class A). The noted deterioration in range condition in the remaining fields is likely a result of prolonged periods of past overuse (overgrazing).

Range condition ratings as low as 32% (Class C, Fair) were observed in some of the fields surveyed. The wide range of condition ratings noted appears to be a reflection of differences in site characteristics (e.g. topography, distance to water) and plant community characteristics (e.g. species composition, palatability, susceptibility to grazing).

The apparent trend in soil condition is generally upward while the overall vegetation trend is downward. Although the browse condition data collected in the present study is very limited due to the reconnaissance nature of the survey, it can be concluded that the overall browse condition in areas grazed by livestock and wildlife (inside the pasture) appears to be similar to that in areas assumed to be grazed by wildlife only (outside the pasture). Therefore, no negative interaction is suspected.

4.7 Yield

The total yield was similar for the three range types sampled (western porcupine grass, sand grass and western snowberry). However, the proportion contributed by the graminoid (grasses and grass-like plants) component was significantly lower in the snowberry type than the other two types.

The yield data are comparable to or greater than those reported for the moister years in other mixed prairie locations in Saskatchewan in spite of the fact that the precipitation for the April-July period,

1981 was below normal.

4.8 Utilization

An attempt was made to construct a practical utilization guide for the key species (western porcupine grass) in the area. Although the guide appears to agree fairly well with data from other areas, it is felt that additional field data (e.g. one year) would be useful to improve its predictive value.

Percentage utilization of the key species showed generally wide variations. Underutilization is apparent in relatively large areas in several fields. This appears to be closely related to topography and location of watering points.

Salt blocks and back scratchers are generally placed near watering points, a practice which often leads to an unacceptable enlargement of the "sacrifice" areas.

4.9 Grazing Capacity and Stocking Rates

Grazing capacity estimates were derived for each of the major fields after considerations were given to the following:

(a) available literature

(b) actual stocking rates

(c) present range condition and trend

(d) topography

(e) shrub and tree density

(f) palatability of the dominant species

The overall grazing capacity estimates varied between fields (0.81 to 3.8 ha/AUM (Animal Unit Month), usable area basis). The overall average for the pasture is 0.98 ha/AUM. This translates

into a total of 2333 AU for a five-month grazing season.

The recommended stocking rates were determined upon adjustment of the carrying capacity estimates obtained on the basis of the present range condition. This affected only those fields with an average range condition class below "Class A". The recommended rates range from 0.85 ha/AUM to 4.74 ha/AUM depending on the field. The overall average for the pasture is 1.23 ha/AUM. The total stocking rate recommended at present is estimated to be 1863 AU for a five-month grazing season. This represents a reduction of approximately 20% from the estimated grazing capacity, a necessary measure to induce progression or an upward trend to enable the attainment of the potential productivity (Excellent Range Condition). The pasture was stocked in 1981 at a rate near the potential grazing capacity.

5. RECOMMENDATIONS

(1) It is recommended that stocking rates formulated on the basis of this study (total of 1863 AU for a five-month grazing season) be followed starting in 1982 in order to provide for maintenance and improvement of range condition in the pasture. The rate of recovery is expected to vary from one field to another depending mainly on present range condition and trend. It is expected that recovery will take several to many years but can be speeded up considerably by implementation of appropriate range improvement measures (Recommendations #2, 3, 4). It should be noted that excessive stocking rates are expected to result in further deterioration in range condition. Future range condition and trend analysis (Recommendation #6) would determine future needs for upward adjustments towards the grazing capacity levels developed in the present study (total of 1863 AU for a five-month grazing season). Minor downward adjustments of stocking rates may be necessary in dry years depending on the percentage utilization attained towards the end of the grazing season.

(2) It is recommended that large-scale range fertilization trials be conducted in the pasture area to determine the most economical fertilization rate. A substantial increase in yield and quality of forage is expected. Experience elsewhere in the mixed prairie grassland showed that a 2 to 4 fold increase in yield as a result

of fertilization is common (Kilcher *et al.*, 1965; Johnson *et al.*, 1967; Wight and Black, 1972, Lorenz and Rogler, 1973; Wight, 1976). Fertilization also improves species composition (Cosper *et al.*, 1967, Wight and Black, 1972; Goetz, 1975a; Wight, 1976) and increases protein content of range plants (Cosper *et al.*, 1967; Goetz, 1975b; Wight 1976). Furthermore, fertilization appears to be an effective means of improving livestock distribution (Smith and Lang, 1958). It should be noted that the benefits from fertilization are not restricted to the year of application. Several years of residual effects have been indicated in most of the above-mentioned studies.

(3) It is recommended that shrub (mainly western snowberry) control be considered as means of range improvement in the pasture area. While air photo examination of the areas sprayed previously (A4, A4a, C5, C6, C6a, D2) for control of snowberry revealed no definite reduction in shrub content compared to the nonsprayed areas, it should be noted that the latest spraying has taken place nine years ago. Also, no data are available on the shrub content prior to spraying, the degree of control attained, and the increase in grass production. Predominantly shrub types cover nearly one-third of the area. Negligible graminoid production is noted in dense snowberry stands. It is expected that the reduction in snowberry density would result in substantial increase (e.g. 3-fold increase in field no. A4a, see table 3.16) in grass production.

It should be noted, however, that complete control of shrubs is neither possible nor desirable and that climatic factors do have some effects on the behaviour of the shrub component in this area.

(4) It is recommended that appropriate measures should be taken to improve grazing distribution. Additional cross-fencing is required in several fields (Figures 5.1) to enable better use of the upland areas. This should be accompanied by appropriate development of watering points. Salt blocks and oilers should not be placed close to watering points. Proper selection of their location is essential to avoid excessive "sacrifice" areas and improve grazing use in areas further away from the water.

(5) It is recommended that additional field data be obtained to improve the utilization guide prepared in the present study. The present guide was based on one year's data. Additional data on the weight-height relationship of the key species would improve the accuracy of the guide. The guide should provide a simple, rapid and effective means of evaluating actual use for many pastures in the Weyburn area.

(6) It is recommended that range condition and trend be resurveyed every few years (depending on the type of range improvement procedure adopted, Recommendations 2, 3, 4) in a selected number of fields in the Coalfield Pasture. While the stocking

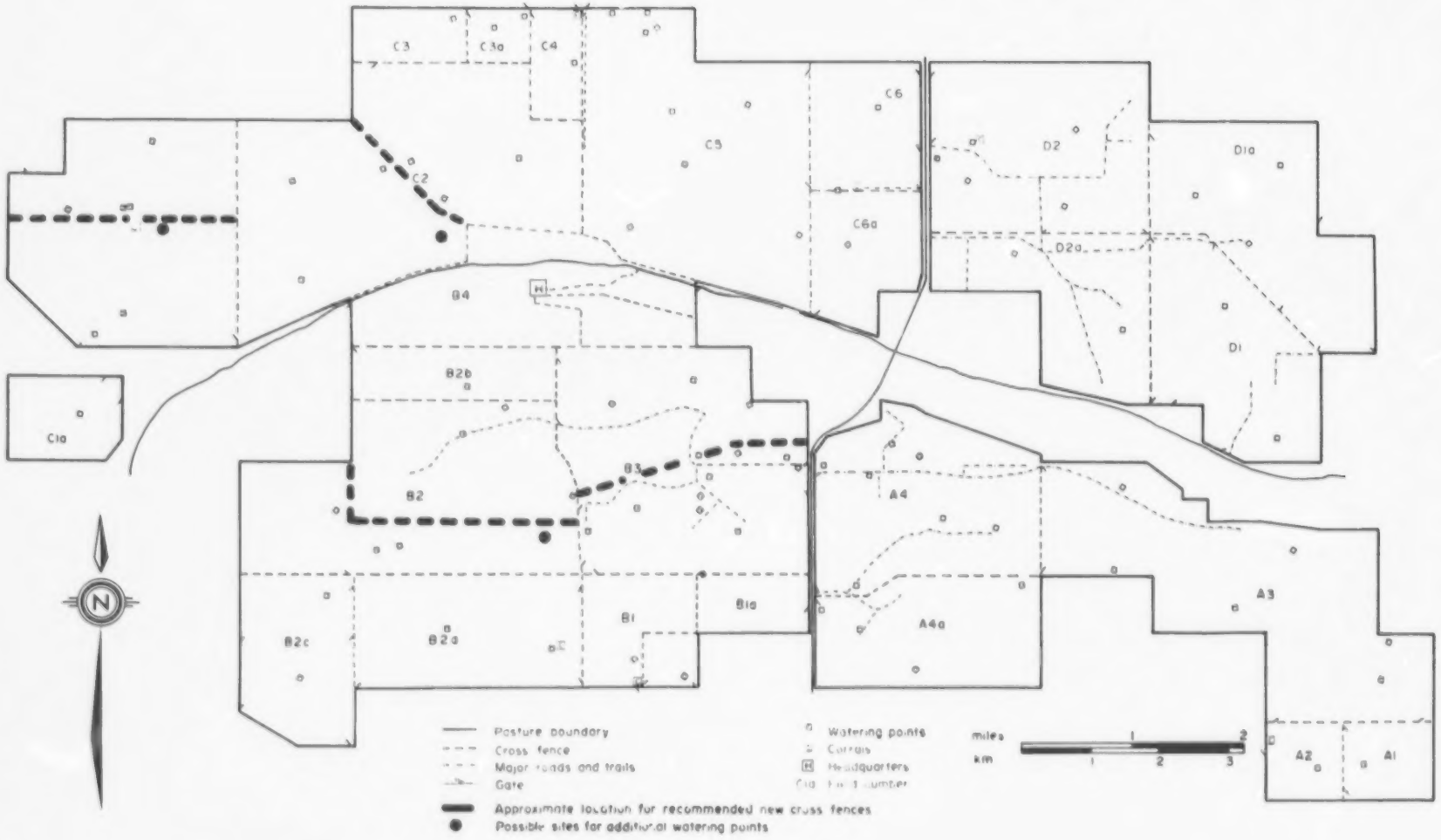


Figure 5.1 Recommended New Cross Fences and Watering Points for the Coalfields Community Pasture.

rates developed in the present study represent the best estimates on the basis of the presently available data, future monitoring of range condition and trend would provide additional data for further refinement of grazing capacity estimates.

(7) It is recommended that standardized approaches and methodology for range evaluation and analysis in PRFA pastures be developed. An outline of the recommended procedure is presented in Figure 5.2. The procedure illustrated is essentially the same one employed in the present study and is explained elsewhere in this report. While it is recommended that this procedure be applied to all PFRA pastures, it is realized that only gradual implementation would be possible in view of the large number of pastures involved, staff limitations and financial constraints. Therefore, it is strongly recommended that the following aspects be given high priority:

(a) A reconnaissance range condition survey of the pastures administered by PFRA. The survey would be limited to a number of "diagnostic" fields to be selected upon examination of air photos and past use records (and possibly field assessment). The main purpose is to identify "problem pastures" where more intensive surveys are urgently needed.

(b) A compilation of relevant available information for each pasture. This should be useful in providing a preliminary

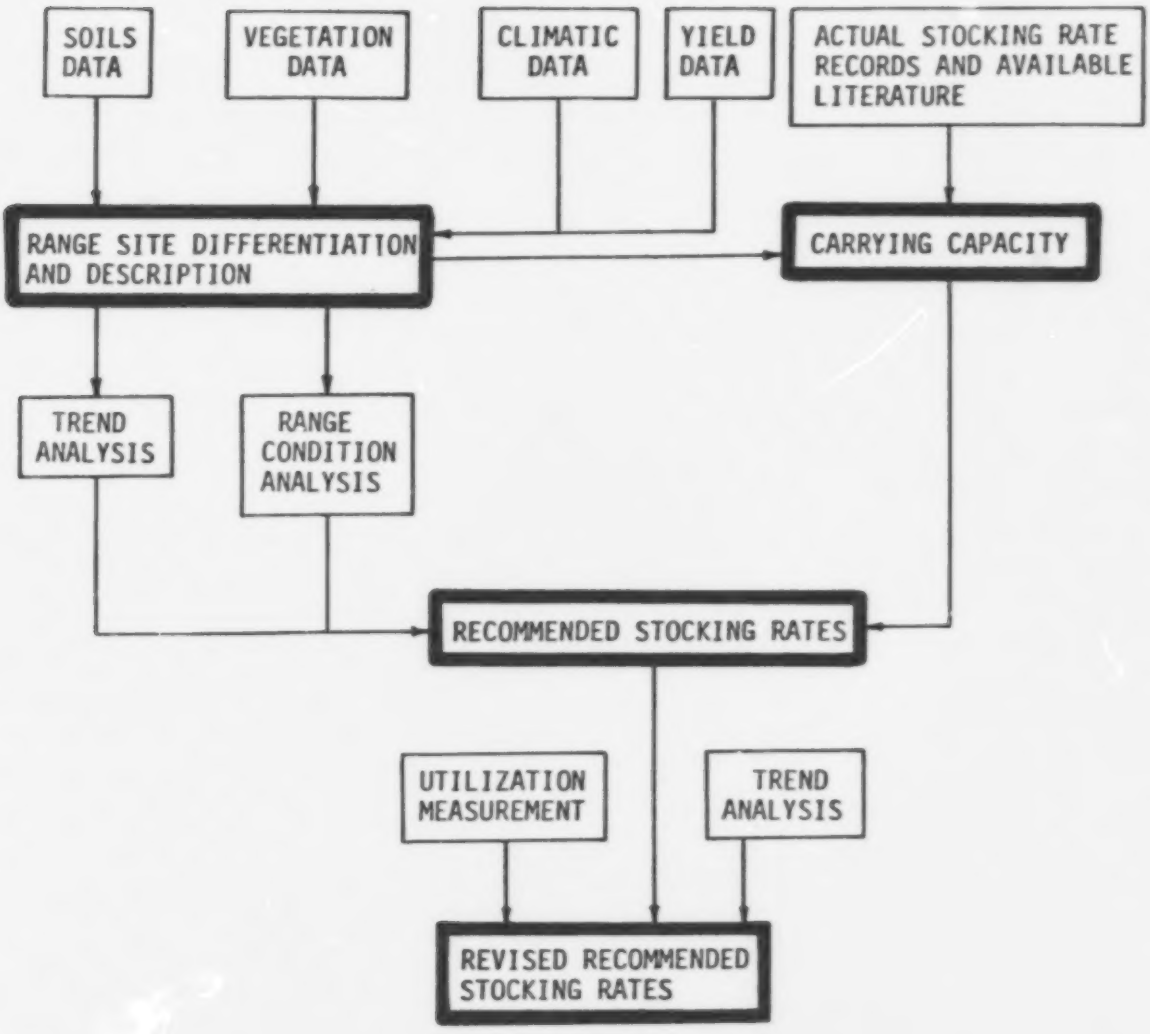


Figure 5.2 Recommended Procedure for Range Analysis in PFRA Community Pastures.

assessment and a background for the more comprehensive range analysis to be conducted in the future. This information should include such aspects as soils, vegetation, wildlife, precipitation, actual stocking rates, seeding and spraying for brush control.

(8) It is recommended that a pasture data system be developed and operated. The recommended data system is needed to store, retrieve and analyze the data to be generated by the range evaluation procedure recommended above. Such a system is essential due to the large numbers of pastures administered by PFRA and the magnitude and variety of data expected.

LITERATURE CITED

Acton, C. J. and J. S. Clayton. 1967. A.R.D.A. Soil Capability and Land Inventory, Rural Municipality No. 4, Coalfields. Saskatchewan Institute of Pedology, Univ. of Sask., Saskatoon.

Acton, C. J. and J. G. Ellis. 1978. The Soils of the Saskatoon Map Area 73-B SASKATCHEWAN. Saskatchewan Institute of Pedology Publication 54, Extension Publication 306.

Anderson, D. A. 1981. (Unpublished) Preliminary soil mapping of Weyburn Map Sheet. Saskatchewan Institute of Pedology, Univ. of Sask., Saskatoon.

Black, A. L. and A. Bauer. 1981. Organic Carbon and Total Nitrogen Levels in Three Soil Textural Groups in Two Grassland and Two Cropland Management Systems. In General Index to 1981 Abstracts, 73rd Annual Meeting American Society of Agronomy, p. 209.

Chakravarti, A. K. 1969. The Climate of Saskatchewan. In Richard, J. H. and K. I. Fung. Atlas of Saskatchewan, Univ. of Sask., p. 60.

Cosper, H. R., J. R. Thomas, and A. J. Alsayegh. 1967. Fertilization and its effect on range improvement in the northern Great Plains. J. Range Manage. 20:216-222.

Coupland, R. T. 1974. Producers: VI. Summary of Studies of Primary Production by Biomass and Shoot Observation Methods. Canadian Committee for IBP, Matador Project. Technical Report No. 62. 84 pp.. Saskatoon, Canada: Univ. of Sask.

Environment Canada. 1981. Canadian Weather Review. Atmospheric Environment Service, Environment Canada, Ottawa. Vol. 19:1-12.

Frankton, C. and G. A. Mulligan. 1970. Weeds of Canada. Canada Dept. of Agric. Publication 948.

Goetz, H. 1975a. Availability of nitrogen and other nutrients on four fertilized range sites during the active growing season. J. Range Manage. 28(4):305-310.

Goetz, H. 1975b. Effect of site and fertilization on protein content of native grasses. J. Range Manage. 28(5):380-385.

Holscher, C. and Woolfolk, E. 1953. Forage utilization by cattle on northern Great Plains ranges. U.S. Dep. Agric. Cir. 918.

Johnston, A., S. Smoliak,A. D. Smith, and L. E. Lutwick. 1967. Improvement of southeastern Alberta range with fertilizers. Can. J. Plant Sci. 48:671-678.

Kilcher, M.R., S. Smoliak, W. A. Hubbard, A. Johnston, A. T. H. Gross, and E. V. McCurdy. 1965. Effects of inorganic nitrogen and phosphorus fertilizers on selected sites of native grassland in western Canada. Can. J. Plant Sci. 45:229-237.

Lodge, R. W. 1954. Effects of grazing on the soils and forage of mixed prairie in southwestern Saskatchewan. J. Range Manage. 7:166-170.

Lodge, R. W., A. McLean, and A. Johnston. 1968. Stock-poisoning Plants of Western Canada. Canada Dept. of Agric. Publication 1361. 34 pp.

Looman, J. 1980. The vegetation of the Canadian Prairie Provinces II. The grasslands, Part I. Phytocoenologia 8(2):153-190.

Lorenz, R. J. and G. A. Rogler. 1973. Growth rate of mixed prairie in response to nitrogen and phosphorus fertilization. 26(5): 365-368.

Maher, R. V., G. W. Argus, V. L. Harms, and J. H. Hudson. 1979. The Rare Vascular Plants of Saskatchewan. Nat. Mus. of Canada. Syllogeus No. 20.

Martens, H. E. 1979. Content and distribution of organic matter in natural and managed ecosystems in the mixed prairie grasslands region in Saskatchewan. M.Sc. Thesis, Dept. of Plant Ecology, Univ. of Sask., Saskatoon. 135 pp.

McKay, G. A., J. Maybank, O. R. Mooney, and W. L. Pelton. 1967. The Agricultural Climate of Saskatchewan. Dept. of Transport, Meteorological Branch. Climatological Studies No. 10. 18 pp.

Mitich, L. W., B. L. Bohmont, H. O. Alley, N. E. Harrington. 1962. Wyoming's Primary Noxious Weeds. Agricultural Experiment Station. University of Wyoming. 40 pp.

Smith, D. R. and R. L. Lang. 1958. The effect of nitrogenous fertilizers on cattle distribution on mountain range. J. Range Manage. 11:248-249.

Smoliak, S., R. A. Wroe, A. Johnston, and M. G. Turnbull. 1976a. Guide to Range Condition and Stocking Rates for Alberta 1976. Alberta Energy and Natural Resources. 26 pp.

Smoliak, S., A. Johnston, M. R. Kilcher, and R. W. Lodge. 1976b. Management of Prairie Rangeland. Canada Dept. of Agric. Public. No. 1315. 30 pp.

U.S. Forest Service. 1977. Range Analysis Handbook. FSH 2209.21 R-1.

U.S. Soil Conservation Service. 1975. North Dakota Range Guide Sec. II-E Range Sites.

Wight, J. R. 1976. Range fertilization in the northern Great Plains. J. Range Manage. 29:180-185.

Wight, J. R. and A. L. Black. 1972. Energy fixation and precipitation-use efficiency in a fertilized rangeland ecosystem of the northern Great Plains. J. Range. Manage. 25:376-380.

APPENDICES

Appendix A . Terms of Reference of the Present Study.

a) Compile a detailed biophysical inventory of the Coalfields PFRA Community Pasture as determined by field investigations, analysis of air photos and soils maps and other relevant existing information.

b) Provide a detailed assessment of present range conditions including such aspects as vegetation condition and composition, soil condition, site-specific data, relicts and relationship of such aspects to overall range condition.

c) The Consultant shall provide PFRA with a progress report every three months, outlining progress to date in the completion of the survey and compilation of related data.

d) The Consultant shall provide PFRA with an interim written report on the results of the ecological rangeland survey by October 30, 1981.

e) It is intended that the document will include maps, drawings, charts, tables and narrative covering, but not limited to, the following elements of the ecological rangeland survey of the Coalfields PFRA Community Pasture:

1. History of land use
2. Detailed description of survey approach and methodology
3. Description of range sites
4. Results and discussion of range condition survey
5. Commentary as to extent of non-agricultural utilization by wildlife and possible implications for multiple use of the concerned rangeland

6. Recommendations as to management practices including but not limited to such factors as stocking rates, seeding, control of undersirable species, grazing systems, fertilization and fencing
7. Range site map outlining vegetation types, soils and present facilities
8. Present range condition map
9. Recommended management and improvement map
10. Detailed technical data and plant lists

f) It is intended that the Consultant will involve designated range management and land use specialist staff of PFRA to such extent as reasonably possible during the field investigation phase of the survey for the purposes of acquainting such staff with the survey study and data collection methods to be used.

g) The Consultant shall provide PFRA with a penultimate draft of the document by February 28, 1982, for review and comment prior to the provision of the final document by the Consultant.

Appendix B-1 Location and Description of Areas where Soil Samples were Collected.

SRC Ident. No.	Field No.	Horizon and Depth (cm)	General Topography	Dominant Species**
1	A4	A (0- 8)	Moderately undulating	A
2	A4	B (8 - 30)		A
3	B1	A (0 - 10)	Moderately undulating	C
4	B1	B (10 - 30)		C
5	B1	A (0 - 10)	Moderately undulating	B
6	B1	B (10 - 28)		B
7	B1	A (0 - 10)	Moderately undulating	A
8	B1	B (10 - 30)		A
9	B3	A (0 - 8)	Steeply sloping	A
10	B3	B (8 - 18)		A
11	C1	A (0 - 10)	Moderately undulating	C
12	C1	B (10 - 30)		C
13	C1	A (0 - 10)	Moderately undulating	B
14	C1	B (10 - 25)		B
15	C1	A (0 - 10)	Moderately undulating	A
16	C1	B (10 - 30)		A

Appendix B-1 (continued)

SRC Ident. No.	Field No.	Horizon and Depth (cm)	General Topography	Dominant Species**
17	C1	A(0 - 10)	Moderately sloping	A
18	C1	B(10 - 25)		A
19	C2	A(0 - 8)	Lower part of steeply sloping valley wall	C
20	C2	B(8 - 30)		C
21	C2	A(0 - 8)	Middle part of steeply sloping valley wall	A
22	C2	B(8 - 30)		A
23	C5	A(0 - 18)	Moderately undulating	A - C
24	C5	B(18 - 33)		A - C
25	C6	A(0 - 10)	Moderately undulating	A
26	C6	B(10 - 25)		A
27	D2	A(0 - 10)	Moderately undulating	C
28	D2	B(10 -		C
29	D2	A(0 - 10)	Moderately undulating	B
30	D2	B1(10 -35)		B
31	D2	B2(> 35)		B
32	D2	A(0 - 13)	Moderately undulating	A - C
33	D2	B(13 - 30)		A - C

Appendix B-1 (continued)

SRC Ident. No.	Field No.	Horizon and Depth (inches)	General Topography	Dominant Species**
34	D2	A(0 - 10)	Moderately undulating	A - D
35	D2	B(10 - 38)		A - D

** Dominant species.
A: Western Porcupine Grass
B: Sand Grass
C: Western Snowberry
D: Blue Grama

Appendix B-2. Number of Sampling Areas Examined in the Range Condition Survey

Field No.	No. of Sampling Areas	Dominant Species*
A3	6	A, B, C, E
A4	4	A, B, C, E
A4a	4	A, B, C, E
B1	3	A, B, C, E
B1a	3	A, B, C
B2	8	A, B
B2a	4	A, B, C
B2b	2	A, B
B2c	3	A, B, C
B3	5	A, B, C, E
B4	3	A, B, E
C1	5	A, C, E, F
C1a	3	A
C2	6	A, B, C
C3	3	A, C, F
C5	8	A, C, E, F
C6	4	A, B, C, E
C6a	3	A, B, E
D1	6	A, B, C, D, E
D1a	4	A, B, C, E, F
D2	7	A, B, C, E, F
D2a	5	A, B, C, E
TOTAL	99	

* A Western Porcupine Grass (*Stipa spartea* var. *curtiseta*)
B Sand Grass (*Calamovilfa longifolia*)
C Western Snowberry, Buck Brush (*Symphoricarpos occidentalis*)
D Silverberry, Wolf-Willow (*Elaeagnus commutata*)
E Pasture Sage (*Artemisia frigida*)
F Blue Grama (*Bouteloua gracilis*)

Appendix B-3 . An Example of Range Condition Calculations (Field B2c - Loamy Site)

Step 1 Determination of Mean Percentage Composition by Estimated Weight.

Coalfields Pasture Study - Field Data Sheet

Field No.: B2c Sample No.: 3 Date: August 16, 1981
Observers: B. G., J. H.

	Estimated % Composition by Weight										
SHRUBS	1	2	3	4	5	6	7	8	9	10	Mean
Elaeagnus commutata											
Rosa arkansana		T			5					T	1
Symphoricarpos occidentalis											
FORBS											
Artemisia frigida	25		15	20	10		15		15	10	11
Other forbs	10	20		15	5		10	5	10	20	9
GRAMINOIDS											
Agropyron dasystachyum			T								T
A. smithii		T	T		10	5	T		5	T	2
A. subsecundum							T				T
Agrostis scabra											
Andropogon scoparius											
Bouteloua gracilis	15	5	5	10	40		25	30	10		14
Calamagrostis montanensis											
Calamovilfa longifolia	T	10	15			5	T	5		10	5
Distichlis stricta											
Festuca ovina											
Koeleria cristata	5			20	5	10	5	5	5	15	7
Muhlenbergia richardsonis				20							2
Poa pratensis											
Stipa comata	T				5						T
S. spartea var. *curtiseta*	30	40	45	10		10	20	35	10	35	24
S. viridula					5						
Carex spp. (upland species)	15	25	20	5	15	70	25	20	45	10	25

Appendix B-3 . (continued)

Step 2 Determination of the Proportion of the Climax Species Present.

Species or Groups	Estimated * Composition %	Climax Portion %	Explanation
Shrubs	1	1	Increaser, up to 5% allowed in climax vegetation
Artemisia frigida	11	5	Increaser, up to 5% allowed
Other forbs	9	5	Increaser, up to 5% allowed
Agropyron smithii	2	2	Decreaser, any amount present is included
Bouteloua gracilis	14	5	Increaser, up to 5% allowed
Calamovilfa longifolia	5	5	Increaser, up to 5% allowed
Koeleria cristata	7	5	Increaser, up to 5% allowed
Muhlenbergia richardsonis	2	2	Increaser, up to 5% allowed
Stipa spartea var. *curtiseta*	24	24	Decreaser, any amount present is included
Carex spp.	25	10	Increaser, up to 10% allowed
	100	64	

*From Step 1

Appendix B-3 . (continued)

Step 3 Determination of the Range Condition Class.

Of the vegetation present in sample number 3, 64 percent (Step 2) is original or climax for the site. The range condition rating would be in Class B - Good condition class using the following table:

Class	Conventional Nomenclature	Climax Percentage Present
A	Excellent	76 to 100
B	Good	51 to 75
C	Fair	26 to 50
D	Poor	0 to 25

Appendix B-4 Parameters Used in Evaluating Trend in Range Condition

	Maximum Rating* +	-
VEGETATION		
- Reproduction of desirable species (seedlings and young plants abundant)	2	
- Reproduction of undesirable species (seedlings and young plants abundant)		2
- Browse in healthy condition (death normal, hedging less than 50% of plants or twigs)	2	
- Browse in poor condition (more than 50% of the plants or twigs are hedged, excessive death of twigs and plants)		2
- Vigor of key species good	2	
- Vigor of key species reduced		2
SOILS		
- Normal litter cover is added	3	
- Litter is not accumulating		3
- No visible accelerated erosion	2	
- Bare soil widespread		2
- Rodent activity normal	1	
- Rodent activity high		1

* Ratings were made in relation to conditions in areas that are protected from grazing or slightly grazed. The approach used in this study is based on the U.S. Soil Conservation Service Range Analysis Handbook.

Appendix B-5. Number of Locations Surveyed for Trend.

Pasture Number	Number of Locations
A3	4
A4	4
A4a	2
B2	6
B2a	2
B3	4
C1	4
C2	4
C5	4
C6	2
D1a	2
D2	2
D2a	2

Appendix B-6. Number of Locations Where Browse Condition was Examined.

Field Number	Snowberry	Silverberry	Total
C2			
inside	4	4	8
outside	4	4	8
C6a			
inside	6	3	9
outside	6	3	9
D1			
inside	6	3	9
outside	6	3	9
TOTAL	32	20	52

Appendix B-7. Form Used in the Browse Condition Survey.*

HEDGING

(1)	Not Evident	
(2)	Moderate	(Up to half of plants)
(3)	Severe	(More than half of plants)

AGE CLASSES (REPRODUCTION)

(1)	Adequate	(Abundant individuals of various age classes)
(2)	Some	
(3)	Little or none	(Few or no young plants)

PRESENCE OF DEAD TWIGS

(1)	Normal	(Few twigs, branches, or plants)
(2)	Moderate	(Several twigs, branches, or plants)
(3)	High	(Many twigs or plants)

*Based on U.S. Soil Conservation Range Analysis Handbook.

Appendix B-8. Number of Quadrats Clipped for Determination of Maximum Standing Crop (Yield).*

Field Number	Dominant Species			Total
	Porcupine Grass	Sand Grass	Snowberry	
B2	5	5	5	15
B4	5	5	5	15
C1a	5	5	5	15
C2	5	5	5	15
C6	5	0	0	5
Total	25	20	20	65

* The maximum standing crop (yield) data represent only minimal estimates of total above-ground net primary productivity mainly because the approach does not consider the above-ground biomass dynamics (e.g. regrowth, transfer to the standing dead and litter compartments, losses due to decomposition and leaching, losses due to removal by consumers). However, the maximum standing crop approach provides data that can be readily interpreted on the basis of available allowable use information. At present, such information is not available for net primary productivity data in this type of grassland.

Appendix B-9 Location and Number of Samples Used in the Utilization Survey.

Field Number	Number of Samples*	
	Height Measurements	Biomass (Weight)
A3	10	2
A4	10	2
B2	10	2
B3	10	2
C1	10	2
C2	10	2
C5	10	2
D1a	10	2
D2	10	2

* Each sample consists of 10 individual bunches of the key plant species: western porcupine grass.

Appendix B-10 Number of Samples Clipped to Construct a Utilization Guide for the the key species Western Porcupine Grass.

Height	Number of Samples (ten bunches each)
0 - 1"	20
1 - 2"	20
2 - 3"	20
> 3"	20

Appendix C-1. Complete Analysis of the Soil Samples Collected from the Coalfield Community Pasture in 1981.

SASKATCHEWAN SOIL TESTING LAB
COMPLETE ANALYSIS

LAB.NO.	YOUR NUMBER	ORGANIC MATTER	LIME	PH	CONDUCTIVITY MMHOS/CM	NO3-N PPM	P PPM	K PPM
I81-3887	1	LOW	ABSENT	7.5	0.2	1	5	345
I81-3888	2	LOW	ABSENT	7.2	0.1	1	2	240
I81-3889	3	MEDIUM	ABSENT	6.1	0.2	4	6	530
I81-3890	4	LOW	ABSENT	6.3	0.1	4	4	350
I81-3891	5	MEDIUM	ABSENT	6.4	0.2	4	5	545
I81-3892	6	LOW	ABSENT	6.4	0.1	1	3	355
I81-3893	7	MEDIUM	ABSENT	6.2	0.1	2	3	430
I81-3894	8	LOW	ABSENT	6.4	0.1	1	1	200
I81-3895	9	LOW	ABSENT	7.6	0.3	2	5	330
I81-3896	10	LOW	HIGH	8.1	0.2	1	2	220
I81-3897	11	MEDIUM	ABSENT	6.4	0.2	3	5	540
I81-3898	12	LOW	ABSENT	6.4	0.1	2	3	335
I81-3899	13	MEDIUM	ABSENT	6.2	0.2	3	4	425
I81-3900	14	LOW	ABSENT	6.7	0.1	1	2	340
I81-3901	15	MEDIUM	ABSENT	6.2	0.1	1	3	365
I81-3902	16	LOW	ABSENT	6.6	0.1	1	1	240
I81-3903	17	LOW	ABSENT	7.3	0.4	80	30	550+
I81-3904	18	LOW	ABSENT	7.7	0.4	36	10	365
I81-3905	19	MEDIUM	ABSENT	7.4	0.2	6	8	465
I81-3906	20	LOW	LOW	8.1	0.2	2	3	140
I81-3907	21	MEDIUM	ABSENT	6.9	0.2	5	6	460
I81-3908	22	LOW	ABSENT	7.7	0.2	2	3	210
I81-3909	23	LOW	LOW	8.2	0.8	20	5	550+
I81-3910	24	LOW	HIGH	8.4	0.3	17	2	375
I81-3911	25	LOW	ABSENT	7.6	0.3	6	3	120
I81-3912	26	LOW	TRACE	8.0	0.3	2	1	120
I81-3913	27	MEDIUM	ABSENT	6.5	0.2	5	5	470
I81-3914	28	LOW	ABSENT	6.5	0.1	1	2	425
I81-3915	29	LOW	ABSENT	7.3	0.3	5	5	350
I81-3916	30	LOW	ABSENT	7.5	0.1	1	2	215
I81-3917	31	ABSENT	ABSENT	8.1	1.1	1	1	125
I81-3918	32	MEDIUM	ABSENT	6.3	3.3	35	8	550+
I81-3919	33	LOW	ABSENT	6.4	1.1	8	4	215
I81-3920	34	MEDIUM	ABSENT	6.6	2.2	10	6	350
I81-3921	35	LOW	ABSENT	6.8	2.2	5	2	220

Appendix C-2. Textural Analysis of the Soil Samples Collected from the Coalfield Community Pasture in 1981.

SASKATCHEWAN SOIL TESTING LAB

SOILTEST LAB NO.	CLIENT LAB NO.	% SAND CONTENT	% SILT CONTENT	% CLAY CONTENT
I81-3887	1	42.86	35.62	21.52
I81-3888	2	46.01	28.90	25.08
I81-3889	3	46.77	30.52	22.70
I81-3890	4	60.71	23.09	16.20
I81-3891	5	51.41	30.77	17.83
I81-3892	6	62.35	22.73	14.92
I81-3893	7	54.68	27.71	17.61
I81-3894	8	54.58	26.74	18.68
I81-3895	9	47.50	23.82	28.69
I81-3896	10	36.58	33.31	30.11
I81-3897	11	50.69	30.27	19.05
I81-3898	12	66.46	18.67	14.88
I81-3899	13	46.65	29.74	23.61
I81-3900	14	56.30	25.53	18.17
I81-3901	15	51.09	30.04	18.87
I81-3902	16	57.09	26.61	16.30
I81-3903	17	47.20	29.35	23.45
I81-3904	18	51.83	16.43	31.75
I81-3905	19	52.11	26.35	21.54
I81-3906	20	55.44	23.38	21.18
I81-3907	21	54.99	24.85	20.16
I81-3908	22	56.77	21.04	22.19
I81-3909	23	34.68	37.85	27.47
I81-3910	24	32.10	33.48	34.42
I81-3911	25	57.73	26.52	15.75
I81-3912	26	56.40	26.09	17.50
I81-3913	27	69.77	18.16	12.07
I81-3914	28	60.85	24.45	14.70
I81-3915	29	75.44	13.23	11.33
I81-3916	30	79.09	11.79	9.11
I81-3917	31	83.66	6.29	9.84
I81-3918	32	35.78	40.58	23.65
I81-3919	33	54.01	27.33	18.66
I81-3920	34	39.91	38.56	21.53
I81-3921	35	58.00	25.80	16.20

Appendix C-3. Percentage Organic Carbon in the Coalfields Soil Samples.

SASKATCHEWAN SOIL TESTING LABORATORY

LAB. NO.	ORGANIC CARBON	INORGANIC CARBON
I81-3887	2.90	
3888	1.39	
3889	6.35	
3890	1.91	
3891	5.18	
3892	2.25	
3893	4.11	
3894	1.32	
3895	5.07	
3896	1.52	1.75
3897	4.69	
3898	1.71	
3899	5.74	
3900	1.70	
3901	4.65	
3902	2.02	
3903	5.55	
3904	2.35	
3905	4.16	
3906	1.79	
3907	5.56	
3908	2.33	
3909	3.86	
3910	1.55	1.65
3911	3.67	
3912	1.48	0.30
3913	5.15	
3914	1.39	
3915	3.58	
3916	0.94	
3917	0.38	
3918	8.08	
3919	1.27	
3920	5.47	
3921	0.96	

Appendix C-4. Percentage Total Nitrogen in the Coalfields Soil Samples.

SASKATCHEWAN SOIL TESTING LAB

OUR LAB NO.	YOUR LAB NO.	%N	%P	%K
NOTE: 0.00 INDICATES ELEMENT NOT PROCESSED				
I81-3887	1	0.3438	0.0000	0.0000
I81-3888	2	0.1440	0.0000	0.0000
I81-3889	3	0.4500	0.0000	0.0000
I81-3890	4	0.1649	0.0000	0.0000
I81-3891	5	0.3888	0.0000	0.0000
I81-3892	6	0.1852	0.0000	0.0000
I81-3893	7	0.3450	0.0000	0.0000
I81-3894	8	0.1260	0.0000	0.0000
I81-3895	9	0.4452	0.0000	0.0000
I81-3896	10	0.1164	0.0000	0.0000
I81-3897	11	0.3434	0.0000	0.0000
I81-3898	12	0.1686	0.0000	0.0000
I81-3899	13	0.4624	0.0000	0.0000
I81-3900	14	0.1649	0.0000	0.0000
I81-3901	15	0.3600	0.0000	0.0000
I81-3902	16	0.1404	0.0000	0.0000
I81-3903	17	0.4942	0.0000	0.0000
I81-3904	18	0.2231	0.0000	0.0000
I81-3905	19	0.3273	0.0000	0.0000
I81-3906	20	0.1313	0.0000	0.0000
I81-3907	21	0.3861	0.0000	0.0000
I81-3908	22	0.2353	0.0000	0.0000
I81-3909	23	0.2992	0.0000	0.0000
I81-3910	24	0.1391	0.0000	0.0000
I81-3911	25	0.3150	0.0000	0.0000
I81-3912	26	0.1610	0.0000	0.0000
I81-3913	27	0.4340	0.0000	0.0000
I81-3914	28	0.1587	0.0000	0.0000
I81-3915	29	0.2910	0.0000	0.0000
I81-3916	30	0.1020	0.0000	0.0000
I81-3917	31	0.0594	0.0000	0.0000
I81-3918	32	0.6813	0.0000	0.0000
I81-3919	33	0.1042	0.0000	0.0000
I81-3920	34	0.4639	0.0000	0.0000
I81-3921	35	0.1140	0.0000	0.0000

APPENDIX C-5 A List of Vascular Plant Species Found in the Study Area.

Scientific Name	Common Name	Lifeform	Vegetation Type*
Acer negundo	Manitoba maple	Tree	4
Achillea lanulosa	woolly yarrow	Perennial Forb	1, 2
Agropyron cristatum	crested wheatgrass	Perennial Grass	1, 2
Agropyron dasystachyum	northern wheatgrass	Perennial Grass	1, 2
Agropyron smithii	western wheatgrass	Perennial Grass	1, 2
Agropyron subsecundum	bearded wheatgrass	Perennial Grass	1, 2
Agropyron trachycaulum	slender wheatgrass	Perennial Grass	3, 4, 5
Agrostis scabra	hair grass	Perennial Grass	1, 5.
Allium textile	prairie onion	Perennial Forb	1
Amelanchier alnifolia	Saskatoon berry	Shrub	2, 3, 4
Andropogon gerardii	big bluestem	Perennial Grass	1
Andropogon scoparius	little bluestem	Perennial Grass	1, 2
Androsace septentrionalis	pygmy flower	Annual Forb	1, 2
Anemone canadensis	Canada anemone	Perennial Forb	3, 5
Anemone cylindrica	long-fruited anemone	Perennial Forb	5
Anemone patens var. *wolfgangiana*	crocus	Perennial Forb	1, 2
Antennaria parvifolia	small-leaved everlasting	Perennial Forb	1
Artemisia campestris	wormwood	Biennial Forb	1, 2
Artemisia frigida	fringed or pasture sage	Perennial Forb	1, 2
Artemisia ludoviciana	prairie sage	Perennial Forb	5
Asclepias ovalifolia	dwarf milkweed	Perennial Forb	1, 2
Aster falcatus	white prairie aster	Perennial Forb	1
Aster laevis	smooth aster	Perennial Forb	3, 4
Astragalus flexuosus	slender milk-vetch	Perennial Forb	1
Bouteloua curtipendula	side-oat grama	Perennial Grass	1
Bouteloua gracilis	blue grama	Perennial Grass	1
Bromus inermis	smooth brome	Perennial Grass	5
Calamagrostis montanensis	plains reed grass	Perennial Grass	1
Calamovilfa longifolia	sand grass	Perennial Grass	1, 2
Campanula rotundifolia	harebell	Perennial Forb	1, 2, 5
Carex eleocharis	low sedge	Sedge	1
Carex filifolia	thread-leaved sedge	Sedge	1
Carex pensylvanica	sun-loving sedge	Sedge	1, 2
Carex praegracilis	graceful sedge	Sedge	2, 5
Cerastium arvense	field chickweed	Perennial Forb	1
Chenopodium album	lamb's-quarters	Annual Forb	3
Chrysopsis villosa	golden aster	Perennial Forb	1
Cirsium arvense	Canada thistle	Perennial Forb	5
Cirsium spp.	thistle	Perennial Forbs	1, 5
Comandra pallida	pale comandra	Perennial Forb	1
Crataegus sp.	hawthorn	Shrub	2, 4
Distichlis stricta	salt grass	Perennial Grass	1, 5
Echinacea angustifolia	purple coneflower	Perennial Forb	1
Elaeagnus commutata	silver-willow, wolfwillow	Shrub	2, 4
Elymus canadensis	nodding wildrye	Perennial Grass	1, 2
Erigeron glabellus	smooth fleabane	Perennial Forb	4
Euphorbia esula	leafy spurge	Perennial Forb	1
Eurotia lanata	winterfat	Shrub	1
Festuca ovina var. *saximontana*	sheep fescue	Perennial Grass	1
Festuca scabrella	rough fescue	Perennial Grass	1
Fraxinus pennsylvanica	green ash	Tree	4
Gaillardia aristida	great-flowered gaillardia	Perennial Forb	1
Galium boreale	bedstraw	Perennial Forb	1, 2, 3
Gentiana spp.	gentian	Perennial Forbs	5
Geum allepicum	yellow avens	Perennial Forb	5
Glycyrrhiza lepidota	wild licorice	Perennial Forb	5
Grindelia squarrosa	gumweed	Perennial Forb	5

APPENDIX C-5 (Continued)

Scientific Name	Common Name	Lifeform	Vegetation Type*
Gutierrezia sarothrae	broomweed	Perennial Forb	1
Helianthus petiolaris	prairie sunflower	Annual Forb	1
Helictotrichon hookeri	hooker's oatgrass	Perennial Grass	1
Heuchera richardsonii	alumroot	Perennial Forb	1
Hordeum jubatum	foxtail barley	Perennial Grass	5
Humulus lupulus	common hop	Perennial Forb	4
Juncus balticus	baltic rush	Rush	5
Koeleria cristata	June grass	Perennial Grass	1
Lactuca pulchella	blue lettuce	Perrennial Forb	1
Liatris punctata	blazing star	Perennial Forb	1
Lygodesmia juncea	skeleton weed	Perennial Forb	1
Malvastrum coccineum	scarlet mallow	Perennial Forb	1
Monarda fistulosa	wild bergamot	Perennial Forb	2
Muhlenbergia racemosa	marsh muhly	Perennial Grass	5, 3
Muhlenbergia richardsonis	mat muhly	Perennial Grass	5
Oxytropis spp.	locoweed	Perennial Forb	1
Panicum virgatum	switch grass	Perennial Grass	1, 2
Petalostemon purpureum	purple prairie clover	Perennial Forb	1
Phlox hoodii	moss phlox	Perennial Forb	1
Poa compressa	Canada blue grass	Perennial Grass	1
Poa palustris	fowl blue grass	Perennial Grass	5
Poa pratensis	Kentucky blue grass	Perennial Grass	1, 2, 3, 5
Populus tremuloides	aspen	Tree	3
Potentilla pensylvanica	praire cinquefoil	Perennial Forb	1
Prunus virginiana	common chokecherry	Shrub	2, 4
Psoralea argophylla	silver leaf psoralea	Perennial Forb	1
Psoralea esculenta	Indian breadroot	Perennial Forb	1
Ratibida columnifera	long-headed coneflower	Perennial Forb	1
Ribes oxyacanthoides	northern gooseberry	Shrub	3
Rosa arkansana	prairie rose	Shrub	1
Rosa woodsii	wood's rose	Shrub	2, 3
Rumex spp.	dock	Perennial Forbs	5
Selaginella densa	club-moss	Perennial Forb	1
Solidago canadensis	graceful goldenrod	Perennial Forb	3, 4
Solidago missouriensis	low goldenrod	Perennial Forb	1
Solidago mollis	velvety goldenrod	Perennial Forb	1
Solidago rigida	stiff goldenrod	Perennial Forb	1
Spiræa alba	narrow-leaved meadowsweet	Shrub	3
Sporobolus heterolepis	prairie dropseed	Perennial Grass	5
Stipa comata	needle-and-thread	Perennial Grass	1
Stipa spartea	porcupine grass	Perennial Grass	1
Stipa spartea var. *curtiseta*	western porcupine grass	Perennial Grass	1, 2
Stipa viridula	green needle grass	Perennial Grass	1, 2
Symphoricarpos occidentalis	western snowberry	Shrub	1, 2, 3, 4
Taraxacum officinale	dandelion	Perennial Forb	1, 3
Thalictrum venulosum	veiny meadow-rue	Perennial Forb	4
Thermopsis rhombifolia	golden-bean	Perennial Forb	1
Tragopogon dubius	goat's beard	Perennial Forb	1
Ulmus americana	American elm	Tree	4
Vicia americana	American vetch	Perennial Forb	1, 2, 3, 4
Viola rugulosa	Western Canada violet	Perennial Forb	4

*Range Types
1: Grass
2: Shrub
3: Aspen
4: Riparian Forest
5: Slough-Meadow Complex

Appendix C-6 Average Species Composition as Estimated in the 1981 Field Survey - Loamy Site (*Stipa-Agropyron*)

Plant Species	Field Number (Number of Quadrats Used)																				
	A3 (38)	A4 (22)	A4a (31)	B1 (25)	B1a (21)	B2 (67)	B2a (38)	B2b (11)	B2c (30)	B3 (36)	B4 (23)	C1 (44)	C1a (28)	C2 (46)	C3 (29)	C5 (71)	C6 (32)	C6a (15)	D1 (49)	D1a (33)	D2 (65)	D2a (45)
SHRUBS																					
Elaeagnus commutata	5	?	T		3	1				2	2	13		3					1		2	
Symphoricarpos occidentalis	16	7	27	16	12		22		6	11	3	10		24	11	15	8	2	20	13	6	9
Others		1	T	1		3		5	1		7	2	3	1	1	1			T		1	1
FORBS																						
Artemisia frigida	18	14	9	13	9	9	7	14	6	13	19	8	3	3	9	12	11	28	11	12	8	7
Others	19	8	13	13	14	13	10	15	12	12	10	7	14	10	9	12	11	7	14	10	19	17
GRAMINOIDS																						
Agropyron dasystachyum		T				1						T	T									
A. smithii	3	2	3	2	1	2	1	9	1	1	1	2	T	2	2	2	4	5	2	1	1	4
A. subsecundum	1		1	3	1	2	1	T	1	1	1	2	1	3	3	1	1		1	T	1	2
Agrostis scabra	T	T	T			T										T	1		T		T	T
Andropogon scoparius	2	3																		3	1	
Bouteloua gracilis	2	4	4	3	4	1	2	11	11	11	3	10	3	1	10	9	7	5	6	5	6	1
Calamovilfa longifolia	5	3	7	9	9	4	8	T	5	12	10	3	15	11	8	6	6	14	5	6	5	5
Distichlis stricta																T	1		T		2	
Festuca ovina	1	2	2			1				T	T					T	T	1	1	2	2	T
F. scabrella	T	3				T				1		1										
Helictotrichon hookeri		1		1	T	T			1		1	T				T		T	T	T	1	1
Hordeum jubatum	1																		1			
Koeleria cristata	2		6	2	T	1	T	1	7	1		2	1	1	4	1		2	3	2	1	3
Muhlenbergia richardsonis	T			T	1	T			1	T	1	T	1	T	2	T	1		T	1	3	T
Panicum spp.		1																				
Poa palustris		1																				
P. pratensis	5	1	3		6	2	15		3	5		3		6	2	2	4	4	1	3	7	4
Sporobolus heterolepis	2	5			6							T				1			T	2	2	1
Stipa comata	1	T			2	7		1	T	3	4	2	3	T		T		1	1			
S. spartea		4																				
S. spartea var. *curtiseta*	7	27	13	23	11	29	22	18	24	14	22	24	37	11	24	23	25	20	19	19	11	23
S. viridula		2		1		1		1	1	1		3	2	5	1	1	6		1		T	7
Carex spp. (mostly upland species)	10	10	11	13	18	21	12	25	19	11	15	8	16	18	14	13	13	11	13	21	19	13
Juncus balticus					1																1	

Appendix C-7 Average Species Composition as Estimated in the 1981 Survey - Sandy Site (*Calamovilfa - Stipa*)

Plant Species	Field Number (Number of Quadrats Used)																				
	A3 (22)	A4 (18)	A4a (9)	B1 (5)	B1a (9)	B2 (13)	B2a (2)	B2b (9)	B3 (14)	B4 (7)	C1 (6)	C1a (2)	C2 (13)	C3 (1)	C5 (9)	C6 (8)	C6a (15)	D1 (11)	D1a (7)	D2 (5)	D2a (5)
SHRUBS																					
Elaeagnus commutata					1			4	4	1	1							3		6	
Symphoricarpos occidentalis	5		4		4	T	3		3	2	6		8		6	1		6	1	4	2
Others		T			1	7		1		1	4					1	T	T			
FORBS																					
Artemisia frigida	22	12	15	13	5	5		2	17	11	10		4	10	6	6	14	5	10		1
Others	8	3	10	7	5	3	2	2	5	8	2	18	6		8	3	7	8	5	9	14
GRAMINOIDS																					
Agropyron dasystachyum						T				1	2										
A. smithii	T	T	1		2	2		1	T	1	1					1	1	1			
A. subsecundum	1	T	4	2	1	4			3	1	4		5				2	1	1	1	2
Agrostis scabra	T	T	T					T													
Bouteloua gracilis	1	3	1		2			2	1		2	5	2		1	7	1			1	
Calamovilfa longifolia	46	61	41	46	44	47	60	63	55	50	49	40	48	35	42	40	43	42	51	45	54
Distichlis stricta																				1	
Festuca scabrella	T	T																			
Festuca ovina	1	2				T			T		3		1		1	1	T	I	1	11	
Helictotrichon hookeri	T	T						1					1								
Koeleria cristata	1		8		1						1				2		T			1	1
Muhlenbergia richardsonis			3	2	1			T					1	15		1		1		1	
Panicum spp.	T								T												
Poa pratensis	T	7	1				33				1		1			1	3	4		6	2
Stipa comata	2	1			3	2		2	1		2		3			1	4				7
S. spartea		1																			
S. spartea var. *curtiseta*	5	6	6	25	15	16	3	8	5	7	6	18	4	35	20	30	16	18	18	6	12
S. viridula		2	1			1			1			2	2								
Carex spp. (upland species)	6	2	7	5	15	13		12	4	18	6	18	14	5	15	7	9	12	14	8	6

Appendix C-8 Description of Main Range Sites Identified in the Coalfields Community Pasture.

1. Loamy Range Sites

This site occurs on nearly level to strongly undulating uplands and moderately to strongly sloping valley and coulee sides.

Soils: well drained, moderately thick to thin, loamy and sandy clay loam soils. Soil taxonomic units in this site include Forget loam, Hillsborough loam and Hillwash.

Potential Vegetation: this site is dominated by cool-season midgrasses. Principal species are western porcupine grass, wheatgrasses, green needlegrass and upland sedges.

Estimated Relative Percent Composition by Weight*:

Western porcupine grass	40%
Needle-and-thread	10%
Bearded wheatgrass	5%
Blue grama	5%
Sand grass	5%
Other grasses**	10%
Sedge	10%
Pasture sage	5%
Other forbs	5%
Woody species	5%

*Based on the Alberta Range Condition Guide (Smoliak *et al* 1976a) and North Dakota Range Guide (U.S. Soil Conservation Service 1975) and modified on the basis of observations from relict areas.

**Includes mainly western wheatgrass, June grass, rough fescue, hooker's oatgrass, and Kentucky bluegrass.

2. Sandy Range Site

This site occurs on nearly level to strongly undulating uplands and to a lesser extent on moderately to strongly sloping valley and coulee sides.

Soils: excessively drained, moderately thick to thin, sandy loam soils. Soil taxonomic units in this site include Forget sandy loam, Hillsborough sandy loam, and to a lesser extent Hillwash soils.

Appendix C-8 (continued)

Potential Vegetation: this site is dominated by sandgrass. Associated species include western porcupine grass, needle-and-thread and upland sedges.

Estimated Relative Percent Composition by Weight*:

Sand grass**	50%
Western porcupine grass	10%
Needle-and-thread	20%
Other grasses***	5%
Sedges	5%
Forbs	5%
Woody species	5%

*Based on Alberta Range Condition Guide (Smoliak *et al* 1976a) and North Dakota Range Guide (U.S. Soil Conservation Service 1975), and modified on the basis of observations from relict areas.

**Although the available literature cited above indicates a much smaller proportion for sand grass on similar sandy sites, our examination of grassland relics in the study area showed it to contribute an average of 50% of the total yield.

***Includes mainly blue grama, wheatgrasses, June grass and Kentucky bluegrass.

APPENDIX C-9 Physical and Chemical Analysis of Soil Samples Collected from the Coalfields Community Pasture (1981). Samples are Grouped According to Dominant Plant Species (Values are means ± standard deviation).*

Vegetation Type	Horizon	Number of Samples	Mineral Content			% Organic Carbon	% N	Lime	pH	Conductivity (mmhos/cm)	Available Nutrients(ppm)		
			% Sand	% Silt	% Clay						N	P	K
UPLAND													
Western porcupine grass (*Stipa spartea* var. *curtiseta*)	A	7	45.24±9.26	33.84±5.66	20.91±3.57	4.68±1.70	0.4011±0.1343	Absent to Low	6.9±0.8	1.0±1.26	11±12	5±1.9	387±147
	B	7	51.2 ±9.30	27.85±5.06	20.98±6.64	1.43±0.32	0.1326±0.0193	Absent to High	7.1±0.8	0.6±0.79	5±6	2±1.1	230±165
Sand grass (*Calamovilfa longifolia*)	A	3	57.83±15.43	24.58±9.8	17.59±6.14	4.83±1.12	0.3807±0.0860	Absent	6.6±0.6	0.2±0.20	4±1	5±0.7	440± 98
	B	3	66.71±13.14	19.10±8.82	14.19±4.39	1.54±0.81	0.1436±0.0554	Absent	7.0±0.7	0.3±0.29	1±0	2±0.8	288±103
Western snowberry (*Symphoricarpos occidentalis*)	A	3	55.74±12.30	26.32±7.06	17.94±5.40	5.40±0.86	0.4091±0.0575	Absent	6.3±0.2	0.2±0	4±1	5±0.7	513± 38
	B	3	62.67± 3.28	22.07±3.02	15.26±0.82	1.67±0.26	0.1640±0.0037	Absent	6.4±0.1	0.1±0	2±1.6	3±1	370± 48
HILLWASH													
Mostly Western porcupine grass	A	4	50.45±3.77	26.09±2.41	23.46±3.74	5.08±0.66	0.4132±0.0723	Absent	7.3±0.3	0.3±0.1	4±2**	6±2**	451± 91
	B	4	50.16±9.29	23.47±7.22	26.30±5.39	2.00±0.40	0.1765±0.0613	Absent to High	7.7±0.3	0.2±0.1	2±1**	3±1**	234± 95

*Detailed data are given in Appendices C-1 to C-4.

**One anomalous value (samples 17, 18) was omitted from the calculations.

Appendix C-10 Proportion of the Climax Species Composition Present - Loamy Site. (Complete procedure is explained in Appendix B-3.)

Plant Species or Groups	Field Number (Number of Quadrats Used)																					
	A3 (38)	A4 (22)	A4a (31)	B1 (25)	B1a (21)	B2 (67)	B2a (38)	B2b (11)	B2c (30)	B3 (36)	B4 (23)	C1 (44)	C1a (28)	C2 (46)	C3 (29)	C5 (71)	C6 (32)	C6a (15)	D1 (49)	D1a (33)	D2 (65)	[illegible]
SHRUBS	5	3	5	4	5	3	5	3	4	5	4	5	3	5	5	5	4	2	5	3	4	[illegible]
FORBS	10	9	10	10	10	10	10	10	10	10	10	9	10	9	10	10	7	10	10	10	10	[illegible]
GRAMINOIDS																						
Agropyron [illegible]						1						T	T									
A. smithii	3	2	3	2	1	2	1	9	1	1	1	2	T	2	2	2	4	5	2	1	1	[illegible]
A. subsecundum	1		1	3	T	2	1	T	1	1	1	2	1	3	3	1	1		1	T	1	[illegible]
Andropogon [illegible]	2	3																				
Bouteloua gracilis	2	4	3	2	3	1	2	5	5	5	3	4	3	1	5	4	3	4	3	1		
Calamovilfa [illegible]	4	3	5	5	5	3	4	1	4	5	4	3	5	5	3	4	4	5	4	4	3	[illegible]
Distichlis stricta																T	1		T		1	
Festuca [illegible]	T	3				1				1		1										
[illegible] pseudaristata		1		1	T	T			1		1	T				T		T	T	T	1	[illegible]
Koeleria macrantha	2		5	2	T	1	T	1	5	1		2	1	1	3	1		2	2	4	1	[illegible]
Muhlenbergia [illegible]	T			T	1	T			1	T	1	T	1	T	2	T	1		T	1	2	[illegible]
Panicum [illegible]		T																				
Poa [illegible]		1																				
P. [illegible]	3	1	3		2	2	4		2	3		2		3	2	2	3	3	1	2	3	[illegible]
Sporobolus [illegible]	2	5			5																	
Stipa [illegible]	1	T			2	6		1	T	3	4	2	3	T		I			T	1	2	[illegible]
S. [illegible]		4														T		1	1			
S. [illegible] var. *[illegible]*	7	2/	13	24	10	29	22	18	23	14	23	24	37	11	24	23	25	20	20	19	12	[illegible]
S. viridula		2		1		1	T	1	1	1		3	2	5	1	1	6		1		T	
[illegible] (mostly upland species)	9	9	7	10	10	10	9	10	10	8	10	8	10	10	9	9	8	10	9	10	8	[illegible]
[illegible]					1																1	
Range Condition Rating	51	77	55	64	55	72	58	59	68	58	62	67	76	55	69	63	67	62	59	59	54	[illegible]

Appendix C-11 Proportion of the Climax Species Composition Present - Sandy Site. (Complete procedure is explained in Appendix B-3.)

Plant Species or Groups	Field Number (Number of Quadrats Used)																				
	A3 (22)	A4 (18)	A4a (9)	B1 (5)	B1a (9)	B2 (13)	B2a (2)	B2b (9)	B3 (14)	B4 (7)	C1 (6)	C1a (2)	C2 (13)	C3 (1)	C5 (9)	C6 (8)	C6a (15)	D1 (11)	D1a (7)	D2 (5)	D2a (5)
SHRUBS	3	T	2		3	4	3	3	4	5	4		2		2	1	T	4	1	3	1
FORBS	5	5	5	5	5	5	2	4	5	5	5	5	5	5	4	5	5	5	4	5	5
GRAMINOIDS																					
Agropyron dasystachyum						T				1	2										
A. smithii	T	T	1		2	1		1	T	1	1					1	1	T			
A. subsecundum	1	T	4	2	1	4			3	1	4		5				2	T	1	1	2
Bouteloua gracilis	1	1	1		2			2	1		2	3	2		1	4	1			1	
Calamovilfa longifolia	45	55	41	46	44	46	50	53	51	48	45	40	48	35	42	40	44	42	51	45	51
Distichlis stricta																				1	
Festuca scabrella	T	T																			
Heliotrichon hookeri	T	T						1					1								
Koeleria cristata	1		4		1						1				2		T			1	1
Muhlenbergia richardsonis			1	2	1			T					1	5		1		1		1	
Panicum spp.	T								T												
Poa pratensis	T	3	1				5				1		1			1	3	2		3	2
Stipa comata	2	1			3	2		2	1		2		3			1	4				4
S. spartea		1																			
S. spartea var. *curtiseta*	5	6	6	25	15	16	3	8	5	8	6	18	4	35	19	30	16	18	17	6	12
S. viridula		2	1			1			1			2	2								
Carex spp. (upland species)	5	2	4	4	5	5		5	4	5	3	5	5	5	5	5	5	5	5	5	5
Range Condition Rating	68	76	71	84	82	84	63	79	75	74	76	73	79	85	75	89	81	77	79	72	83

Appendix C-12 Maximum Standing Crop Data - Coalfields Community Pasture - 1981.

Field No.	Sample No.	Vegetation Type	Weight g/0.25m²				
			Graminoid	Forbs	Shrubs	Forbs & Shrubs	Total
B2	1	*Stipa*	42.76	9.43	1.29		53.48
	2		24.30	3.59	3.18		31.07
	3		40.35	8.09	2.32		50.76
	4		31.58	8.84			40.42
	5		38.30	2.72	.56		41.58
	$\bar{x}$		35.46	6.53	1.47		43.46
	1	*Calamovilfa*	66.27	7.87			74.14
	2		44.75		10.54		55.29
	3		58.07		1.10		59.17
	4		45.07	8.89	0.42		54.38
	5		52.26	7.62	1.93		61.81
	$\bar{x}$		53.28	4.88	2.80		60.96
	1	*Symphoricarpos*	32.87	1.81	12.89		47.57
	2		29.23	6.15	14.05		49.43
	3		34.50	7.09	12.16		53.75
	4		27.81	3.23	12.00		43.04
	5		22.61	5.54	8.16		36.31
	$\bar{x}$		29.40	4.76	11.85		46.01
B4	1	*Stipa*	43.28	8.24	1.00		52.52
	2		64.34	2.01	.37		66.72
	3		38.00	3.17			41.17
	4		43.97	1.51	0.45		45.93
	5		39.69	5.27	2.10		47.06
	$\bar{x}$		45.86	4.04	0.78		50.68

Appendix C-12 (continued)

Field No.	Sample No.	Vegetation Type	Weight g/0.25m²				
			Graminoid	Forbs	Shrubs	Forbs & Shrubs	Total
	1	*Calamovilfa*	66.73	10.29	1.55		78.57
	2		53.04	0.22	2.82		56.08
	3		52.33	3.85	1.36		57.54
	4		38.96		1.27		40.23
	5		38.77	14.78			53.55
	$\bar{x}$		49.97	5.83	1.40		57.19
	1	*Symphoricarpos*	20.20	13.85	8.23		42.28
	2		36.30	23.73	7.49		67.52
	3		33.67	7.11	13.84		54.62
	4		31.72	11.48	14.52		57.72
	5		51.88	5.47	13.49		70.84
	$\bar{x}$		34.75	12.33	11.51		58.60
Cla	1	*Stipa*	54.54	4.66	1.06		60.26
	2		50.86	5.02	1.56		57.44
	3		42.85	2.94	2.45		48.24
	4		45.68	1.95			47.63
	5		41.15	2.04			43.19
	$\bar{x}$		47.02	3.32	1.01		51.35
	1	*Calamovilfa*	44.71	1.25	0.64		46.60
	2		42.49	2.48			44.97
	3		47.45	5.54			52.99
	4		43.93	2.02			45.95
	5		47.55	0.90			48.45
	$\bar{x}$		45.23	2.44	0.13		47.80

Appendix C-12 (continued)

Field No.	Sample No.	Vegetation Type	Weight g/0.25m²				
			Graminoid	Forbs	Shrubs	Forbs & Shrubs	Total
	1	*Symphoricarpos*	40.46	1.48	12.25		54.19
	2		24.39	7.22	17.19		48.80
	3		24.47	3.66	14.18		42.31
	4		28.21	3.50	17.21		48.92
	5		33.18	7.50	9.36		50.04
	$\bar{x}$		30.14	4.67	14.04		48.85
C2	1	*Stipa*	32.61	14.03	2.07		48.71
	2		50.29	2.54	0.17		53.00
	3		47.57			4.68	52.25
	4		34.82	17.92			52.74
	5		30.55	3.49			34.04
	$\bar{x}$		39.17	7.60	0.45	0.94	48.15
	1	*Calamovilfa*	45.92	3.12			49.04
	2		61.76		7.31		69.07
	3		37.92	2.91			40.83
	4		46.88	2.40			49.28
	5		44.85	5.31			50.16
	$\bar{x}$		47.46	2.75	1.46		51.67
	1	*Symphoricarpos*	34.83	T	22.57		57.40
	2		26.37	T	12.32		38.69
	3		31.73	T	14.95		46.68
	4		20.10	T	17.56		37.66
	5		21.31	T	18.57		39.88
	$\bar{x}$		26.87		17.19		44.06

Appendix C-12 (continued)

Field No.	Sample No.	Vegetation Type	Weight g/0.25m^2				
			Graminoid	Forbs	Shrubs	Forbs & Shrubs	Total
C6	1	*Stipa*	43.56	6.07			49.63
	2		44.84	0.28	0.50		45.62
	3		37.33	1.21			38.54
	4		37.57	0.79	10.00		48.36
	5		28.98	1.41			30.39
	$\bar{x}$		38.46	1.95	2.10		42.51

Appendix C-13. Analysis of Variance of the Maximum Standing Crop Data.

TWO-WAY ANOVA OF PLANT WIEGHT BY PASTURE 15-Jan-82

File NONAME (Creation date = 15-Jan-82)

* * * * * * * * * A N A L Y S I S O F V A R I A N C E * * * * * * * * *

WEIGHT
by PASTURE
CMNTYTYP

* *

Source of variation	Sum of Squares	df	Mean Square	F	Signif of F
Main effects	3845.196	6	640.866	9.681	0.000
PASTURE	309.345	4	77.336	1.168	0.336
CMNTYTYP	3565.522	2	1782.761	26.932	0.000
2-way interactions	533.060	6	88.843	1.342	0.256
PASTURE CMNTYTYP	533.060	6	88.843	1.342	0.256
Explained	4378.257	12	364.855	5.512	0.000
Residual	3442.144	52	66.195		
Total	7820.401	64	122.194		

65 Cases were processed.
0 Cases (0.0 %) were missing.

Appendix C-14 . Summary of Data Used in Constructing and Verifying the Western Porcupine Grass Utilization Guide.

	Mean Weight of Increment (g)*			
	Guide Data		Verification Data	
Height (inches)	Number of Samples**	$\bar{x}$ ± SD	Number of Samples**	$\bar{x}$ ± SD
0 - 1	20	2.88 ± 0.70	18	2.04 ± 1.14
1 - 2	20	1.63 ± 0.43	18	0.98 ± 0.57
2 - 3	20	1.34 ± 0.37	18	0.78 ± 0.55
3	20	3.26 ± 2.26	6	1.33 ± 0.93

*Sampling locations are given in Appendices B-9 and B-10.

**Each sample consisted of 10 plants.

Appendix C-15 Summary of the Actual Stocking Rates (ha/AUM) of the Coalfields Community Pasture (1959-1981)*.

	Period						
Field	1959-1962	1963-1967	1968-1972	1973-1977	1979	1981	1959-1981
A1 + A2	1.13	1.53	1.42	1.05	0.98	1.82	1.30
A3	0.95	0.73	0.74	0.65	0.97	0.91	0.76
A4	1.38	0.98	0.42	0.60	0.55	1.02	0.81
A4a	1.38	0.98	0.81	0.67	1.94	1.23	0.95
B2	1.02	0.82	0.85	0.83	0.78	0.77	0.86
B2a	1.02	1.01	1.03	0.74	1.03	0.96	0.95
B3	5.42	0.73	0.67	0.88	0.68	0.82	1.65
C1	0.58	0.84	0.83	0.74	0.58	0.79	0.75
C1a	0.58	0.84	0.83	0.80	1.00	1.12	0.83
C2	0.73	0.77	0.69	0.83	0.79	1.02	0.77
C5	1.03	0.70	0.56	0.59	0.98	1.51	0.76
C6	1.08	0.84	1.07	0.85	1.30	0.93	0.97
C6a	1.08	0.84	1.07	0.68	0.40	1.37	0.91
D1	0.83	0.69	0.52	0.75	1.08	1.34	0.74
D1a	0.83	0.69	0.52	0.90	1.10	1.26	0.77
D2	0.73	1.21	0.63	0.76	0.79	1.17	0.85
D2a	0.73	0.88	0.68	1.27	1.28	1.24	0.93
	1.33	0.87	0.73	0.77	0.91	1.08	0.91

*Data for 1978 and 1980 are not available.

Government of Canada / Gouvernement du Canada

Regional Economic Expansion / Expansion économique régionale

PFRA

Our File: 925/7C2-3

Motherwell Building
1901 Victoria Avenue
Regina, Saskatchewan
S4P 0R5

March 10, 1982

Zoheir M. Abougendia
Research Scientist
Environmental Studies Section
Saskatchewan Research Council
30 Campus Drive
Saskatoon, Saskatchewan
S7N 0X1

Dear Zoheir:

Re: Contract Report - Ecological Investigations of the Coalfields Community Pasture

This is to acknowledge with thanks receipt of the draft copies of the above-mentioned report. Tentatively, I would propose that we meet on Tuesday, April 6, 1982, to discuss any final revisions and changes to the report. At the same time we could arrange a seminar presentation (either late morning or early afternoon of that same day) where the results of your work could be summarized to a larger group of individuals who might have an interest in this study. Please advise me as to the suitability of this date.

As to the classification of this report PFRA would be in agreement with your suggestion that it be designated as a "Technical Report".

Yours truly,

G. M. Luciuk
Manager, Program Planning
Soil and Water Conservation Branch

GML/lla

cc: George S. Brown
George Chu

Canada

Saskatchewan Research Council
30 Campus Drive
Saskatoon, Saskatchewan
Canada
S7N 0X1